TRANSACTIONS

OF THE

ENTOMOLOGICAL SOCIETY

OF

LONDON

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1923.

LONDON:
PUBLISHED BY THE SOCIETY AND SOLD AT ITS ROOMS,
41 QUEEN'S GATE, S.W. 7

1923–1924.

DATES OF PUBLICATION IN PARTS.

Parts I, II	(TRANS., pp. 1–290,	PROC. i-xlviii)	published	10	August, 1923
„ III, IV	(„ 291–743,	„ xlix-xcvi)	„	15	April, 1924
Part V	————————————	„ xcvii-xcix)	„	13	June, 1924

ENTOMOLOGICAL SOCIETY OF LONDON

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MEMOIRS.

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List of Fellows

OF THE

ENTOMOLOGICAL SOCIETY OF LONDON.

HONORARY FELLOWS.

Date of Election.

1900 AURIVILLIUS, Professor Christopher, *Stockholm.*

1915 BERLESE, Professor Antonio, *via Romana*, 19, *Firenze, Italy.*

1905 BOLIVAR, Ignacio, *Museo nacional de Historia natural, Hipodromo*, 17, *Madrid.*

1911 COMSTOCK, Prof. J. H., *Cornell University, Ithaca, New York, U.S.A.*

1894 FOREL, Professor Auguste, M.D., *Yvorne, Canton de Vaud, Switzerland.*

1898 GRASSI, Professor Battista, *The University, Rome.*

1915 ‡ HOWARD, Dr. L. O., *Chief, Bureau of Entomology, U.S. Dept. of Agriculture, Washington, U.S.A.*

1914 LAMEERE, Professor A., 74, *rue Defacq, Bruxelles.*

1918 MARCHAL, Dr. Paul, President of the Entomological Society of France, 45, *rue de Verrières, Antony, Seine, France.*

1908 OBERTHÜR, Charles, *Rennes, Ille-et-Vilaine, France.*

1913 TIAN-SHANSKI, A. P. Semenoff, *Vassili Ostrov*, 8 *lin.*, 39, *Petrograd, Russia.*

1911 WASMANN, Fr. Erich, S.J., *Valkenburg (L.) Ignatius Kolleg, Holland.*

SPECIAL LIFE FELLOWS.

Date of Election.

1916 (1888) YERBURY, Colonel John W., late R.A., F.Z.S. (COUNCIL 1896, 1903–5), 2, *Ryder-street, St. James's*, S.W. 1.

1923 (1889) JOHNSON, The Rev. W. F., M.A., 4, *Killowen-terrace, Rostrevor, co. Down.*

FELLOWS.

(*The names of those who have not yet paid either the Entrance Fee or the first year's subscription are not included.*)

Marked † *have compounded for their Annual Subscriptions.*
Marked ‡ *have been admitted into the Society (to Dec.* 1923).
Marked * *died during the year* 1923.

Date of Election.

1914†‡ADAIR, E. W., B.A., *Turf Club, Cairo, Egypt.*

1913 ‡ ADAMS, B. G., 15, *Fernshaw-road, Chelsea*, S.W.

1902 ‡ ADKIN, Benaiah Whitley, *Trenoweth, Hope-park, Bromley, Kent.*

1885 ‡ ADKIN, Robert (V.-PRES., 1922; COUNCIL, 1901–2, 1911–13, 1921–3), *Hodeslea, Meads, Eastbourne.*

1921 ALEXANDER, Prof. C. P., *Fernald Hall, Mass. Agricultural College, Amherst, Mass., U.S.A.*

1922 ALLEN, Donald, 21, *All Saints'-road, King's Heath, Birmingham.*

1912 ALLEN, J. W., M.A., 266, *Willesden-lane, London,* N.W. 2.

1920 ‡ ALTSON, A. M., *Rothamsted Exp. Statn., Harpenden, Herts.*

1911 ANDERSON, T. J., *Entomological Laboratory, Kabete, Kenya Colony.*

1919†‡ANDREWES, Christopher Howard, *The Rockefeller Inst., 66th-street* and *Avenue A, New York City, U.S.A.*

1910†‡ANDREWES, H. E. (COUNCIL, 1920–22), 8, *North-grove, Highgate,* N. 6.

1922 ANDREWES, H. L., c/o John Heelas, Esq., *Queen Anne's Mansions,* S.W.

1899 ‡ ANDREWS, Henry W., *Woodside, Victoria-road, Eltham,* S.E. 9.

1901 ‡ ANNING, William, 39, *Lime Street,* E.C. 3.

1908 † ANTRAM, Charles B., *Somerdale Estate, Ootacamund, Nilgiri Hills, S. India.*

1913 ‡ ARMYTAGE, Edward O., *Ingleby, Armytage, Victoria, Australia.*

1907 ‡ ARNOLD, G., D.Sc., A.R.C.S., *Rhodesia Museum, Bulawayo, South Africa.*

1899†‡ARROW, Gilbert J. (COUNCIL, 1905–7), 9, *Rossdale-road, Putney,* S.W. 15; and *British Museum (Natural History), Cromwell-road,* S.W. 7.

1922 ARTHUR, Francis, M.R.C.S., L.R.C.P., 395, *Bethnal Green-road,* E. 2.

1911 ‡ ASHBY, Edward Bernard, 36, *Bulstrode-road, Hounslow, Middlesex.*

1907†‡ASHBY, Sidney R., 37, *Hide-road, Headstone, Harrow.*

1921 ATKINSON, Dennis Jackson, *Ataran Forest Division, Moulmein, Burma.*

1886 ATMORE, E. A., 48, *High-street, King's Lynn.*

1914 AWATI, P. R., Medical Entomologist, c/o Grindlay & Co., Bankers 26, *Westmorland-street, Calcutta.*

1922 BACCHUS, Arthur Douglas Reginald, 29, *Abbotsford-road, Redland, Bristol.*

1904†‡BAGNALL, Richard S., 5, *Higham Place, Newcastle-on-Tyne.*

1909 ‡ BAGWELL-PUREFOY, Capt. Edward, *East Farleigh, Maidstone.*

1916 ‡ BALFOUR, Miss Alice, 4, *Carlton-gardens,* S.W., and *Whittingehame, Prestonkirk, Scotland.*

1921 ‡ BALFOUR-BROWNE, F. M., F.R.S.E., F.Z.S., *Oaklands, Fenstanton, St. Ives, Hunts.*

1912 ‡ BALLARD, Edward, *Agricultural Research Station, Long Ashton, Bristol.*

1886 ‡ BANKES, Eustace R., M.A.

1890 BARCLAY, Francis H., F.G.S., *The Warren, Cromer.*

1920 ‡ BARNS, Thomas Alexander, F.Z.S., 22, *Barkston-gardens, Earls Court,* S.W.

1902 ‡ Barraud, Philip J., *Central Research Institute, Kasauli, Punjab, India.*

1907 ‡ Bartlett, H. Frederick D., *Island of St. Helena, S. Atlantic.*

1894†‡ Bateson, Prof. William, M.A., F.R.S., Fellow of St. John's College, Cambridge, *The Manor House, Merton, Surrey.*

1908 Bayford, E. G., 38, *Eldon-street, Barnsley.*

1904 Bayne, Arthur F., c/o Messrs. Freeman, *Castle-street, Framlingham, Suffolk.*

1912 ‡ Baynes, Edward Stuart Augustus, 44, *Primrose Mans., Battersea-park,* S.W. 11.

1896†‡ Beare, Prof. T. Hudson, B.Sc., F.R.S.E. (V.-Pres., 1910; Council, 1909–11), 10, *Regent Terrace, Edinburgh.*

1908 ‡ Beck, Richard, 18, *Victoria-road, Clevedon, Som.*

1912 Bedford, Gerald, Entomologist to the Union of South Africa, Veterinary Bacteriological Laboratory, *Ondestepoort, Pretoria, Transvaal.*

1913 Bedford, Capt. Hugh Warren, *W.T.R. Laboratories, Khartoum, Sudan.*

1899 ‡ Bedwell, Ernest C. (V.-Pres., 1922; Council, 1917–19, 1922–), *Bruggen, Brighton-road, Coulsdon, Surrey.*

1920 ‡ Beeson, C. F. C., *Indian Forest Service, Forest Research Institute, Dehra Dun, U.P., India.*

1904 Bengtsson, Simon, Ph.D., Lecturer, *University of Lund, Sweden;* Curator, Entomological Collection of the University.

1915 Benham, Prof. William Blaxland, M.A., D.Sc., F.R.S., *University of Otago, Dunedin, New Zealand.*

1906 ‡ Bentall, E. E., *The Towers, Heybridge, Essex.*

1913 ‡ Best-Gardner, Charles C., *Rookwood, Neath, Glamorgan.*

1920 ‡ Bethell, George, F.R.Hist.S., F.L.A., 11, *Chandos-street,* W. 1.

1885 ‡ Bethune-Baker, George T., F.L.S., F.Z.S. (Pres., 1913–14; V.-Pres., 1910–11, 1915; Council, 1895, 1910–15, 1919–21), 20, *Newbold Terrace, Leamington Spa.*

1918 Beveridge, Brigadier-Gen. W. W. O., C.B., D.S.O., R.A.M.C., 45*a*, *Chester-square,* S.W. 1.

1891 ‡ Blaber, W. H., F.L.S., 34, *Cromwell-road, Hove, Brighton.*

1904 ‡ Black, James E., F.L.S., *Nethercroft, Peebles.*

1920 Blackmore, E. H., Pres. Brit. Columbia Ent. Soc., *P.O. Box* 221, *Victoria, B.C.*

1904 ‡ Blair, Kenneth G. (Council, 1918–20), *Claremont,* 120, *Sunningfields-road, Hendon,* N.W. 4.

1921 Blenkarn, S. A., *Rannock Lodge, Grovelands-road, Purley, Surrey.*

1904 ‡ Bliss, Maurice Frederick, M.C., M.R.C.S., L.R.C.P., 130, *High Town-road, Luton, Beds.*

1916 ‡ Bocock, Charles Hanslope, *The Elms, Ashley, Newmarket.*

1912 Bodkin, G. E., Govt. Entomologist, *Mount Carmel, Haifa, Palestine.*

1903 Bogue, W. A., 34, *Handen-road, Lee, S.E.* 12.
1911 Boileau, H., 99, *Rue de la Côte St. Thibault, Bois de Colombes, Seine, France.*
1921 ‡ Bolton-King, E., *Balliol College, Oxford.*
1891 Booth, George A., F.Z.S., M.B.O.U., *The Hermitage, Kirkham, Lancs.*
1902 ‡ Bostock, E. D., *Oulton Cross, Stone, Staffs.*
1921 Bouck, Baron J., *Springfield, South Godstone, Surrey.*
1913 Bowater, Lieut.-Col. William, 23, *Highfield-road, Edgbaston, Birmingham.*
1894 † Bowles, E. Augustus, M.A., *Myddelton House, Waltham Cross.*
1912 † Bowring, C. Talbot, *St. Winifred's, Leamington Spa.*
1921 ‡ Box, H. E., *c/o Messrs. S. Davson & Co., Ltd., Plantation Blairmont, New Amsterdam, British Guiana.*
1919 ‡ Box, L. A., 35, *Great James-street,* W.C. 1.
1910 Boyd, A. Whitworth, *Frandley House, nr. Northwich.*
1920 Boyd, Major John Erroll Moritz, M.C., R.A.M.C., *Pendavey, Birchington-on-Sea.*
1905 Bracken, Charles W., B.A., 5, *Carfrae Terrace, Lipson, Plymouth.*
1919 Bradley, Prof. J. Chester, M.Sc., Professor of Entomology and Curator of Invertebrate Zoology, *Cornell University, Ithaca, New York, U.S.A.*
1917 Breijer, Dr. H. G., Ph.D., Director of the Transvaal Museum, *Pretoria, Transvaal, S. Africa.*
1920 ‡ Brenchley, Dr. Winifred E., D.Sc., F.L.S., *Rothamsted Experimental Station, Harpenden, Herts.*
1920 ‡ Brïdson, Miss Mary Francis Cossart, *Ford Brow, Dartmouth.*
1894 ‡ Bright, Percy M., *Colebrook Grange,* 58, *Christchurch-road, Bournemouth.*
1909 Britten, Harry, 22, *Birch-grove, Levenshulme, Manchester.*
1902 ‡ Broughton, Lt.-Col. T. Delves, R.E., 19, *Nettlecombe Avenue, Southsea.*
1904 ‡ Brown, Henry H., 5, *Bruntsfield-crescent, Edinburgh.*
1919 Brown, James Meikle, B.Sc., F.I.S., F.C.S., 176, *Carterknowle-road, Millhouses, Sheffield.*
1910 Browne, Horace B., M.A., *Kenilworth, Scatcherd-lane, Morley, Yorks.*
1909 Bryant, Gilbert E., 163, *Gloucester-terrace, Hyde Park,* W. 2.
1898 † Buchan-Hepburn, Sir Archibald, Bart., J.P., D.L., *Smeaton-Hepburn, Prestonkirk.*
1919 ‡ Buckhurst, A. S., 9, *Souldern-road,* W. 14.
1917 ‡ Buckley, Dr. George Granville, M.D., F.S.A., *Rye Croft South, Manchester-road, Bury, Lancs.*
1916 Bugnion, Prof. E., *La Luciole, Aix en Provence, France.*
1907 Bulleid, Arthur, F.S.A., *Dimboro, Midsomer Norton, Somersetshire.*
1919 ‡ Bunnett, E. J., M.A., 19, *Silverdale, Sydenham,* S.E. 26.

1922 Burns, A. N., *Salisbury-road, Rose Bay, Sydney, N.S.W.*
1896†‡Burr, Malcolm, D.Sc., F.G.S., A.R.S.M. (V.-Pres., 1912; Council, 1903–4, 1910–12), *Cox's Mill, Dallington, Sussex.*
1920 Burras, Alfred Ellis, 3, *Connaught-road, North End, Portsmouth.*
1909 ‡ Burrows, The Rev. C. R. N., *The Vicarage, Mucking, Stanford-le-Hope, Essex.*
1922 ‡ Bushby, Leonard Charles, 11, *Park-grove, Bromley, Kent.*
1920 ‡ Bushell, Capt. H. S., *Ravensholt, Harrow-on-the-Hill.*
1922 Butler, A. E., *The Nook, Cleveden, Somerset.*
1868†‡Butler, Arthur G., Ph.D., F.L.S., F.Z.S. (Sec., 1875; Council, 1876), *The Lilies, Beckenham-road, Beckenham.*
1883 ‡ Butler, Edward Albert, B.A., B.Sc. (Council, 1914–16), 35, *Kyrle-road, West Side, Clapham Common*, S.W. 11.
1902 ‡ Butler, William E., *Hayling House, Oxford-road, Reading.*
1905 ‡ Butterfield, James A., B.Sc., *Ormesby*, 21, *Dorville-road, Lee*, S.E.
1914 † Butterfield, Rosse, Curator, *Corporation Museum, Keighley, Yorks.*
1912†‡Buxton, Patrick Alfred, M.B.O.U., *Fairhill, Tonbridge, Kent*, Publications, c/o *Govt. Hospital, Apia, Western Samoa.*

1917 Cameron, Alfred E., M.A., D.Sc., *University of Saskatchewan, Saskatown, Canada.*
1902 ‡ Cameron, Malcolm, M.B., R.N. (Council, 1919–20), *Pension Mirabeau, Montana Vermala, Switzerland.*
1923 ‡ Campell-Taylor, J. E., *Mavisthorne, Southover, Lewes, Sussex.*
1898 Candèze, Léon, *Mont St. Martin* 75, *Liège.*
1880 Cansdale, W. D., *Sunny Bank, South Norwood*, S.E. 25.
1889 ‡ Cant, A., 33, *Festing-road, Putney*, S.W. 15.
1910 Carlier, E. Wace, M.D., F.R.S.E., *Morningside, Granville-road, Dorridge*, and *The University, Birmingham.*
1892 ‡ Carpenter, The Hon. Mrs. Beatrice, 22, *Grosvenor-road*, S.W. 1.
1919 Carpenter, C. F. Greeves, 35, *Russell-square, London*, W.C. 1.
1910†‡Carpenter, Geoffrey D. H., D.M., B.Ch., c/o *The Honble. the P.M.O., Entebbe, Uganda.*
1895 ‡ Carpenter, George H., D.Sc., M.R.I.A., *The Manchester Museum, The University of Manchester.*
1915 Carr, Professor John Wesley, M.A., F.L.S., F.G.S., Professor of Biology, *University College, Nottingham.*
1923 Carter, A. E. J., *The Retreat, Monifieth, nr. Dundee, N.B.*
1912 Carter, Henry Francis, 7, *Courthope Villas, Worple-road, Wimbledon*, S.W. 19. All communications to *The Bacteriological Institute, Colombo, Ceylon.*
1906 ‡ Carter, H. J., B.A., *Garrawillah, Kintore-street, Wahroonga, Sydney, N.S.W.*
1921 Casling, P. V., c/o Grindlay & Co., 54, *Parliament-st.*, S.W.

1921 CASSELS, O. C., D.F.C., N.D.A., Hon. Dip. (Harper-Adams A. C.), *La Cumbre, Ottery St. Mary, Devon.*

1921 CASTLE, Miss Amy, *Dominion Museum, Wellington, New Zealand.*

1921 ‡ CATOR, Douglas, 13, *Westminster-mansions, Gt. Smith-street,* S.W. 1.

1889†‡CAVE, Charles J. P., *Stoner Hill, Petersfield.*

1920 ‡ LE CERF, F., Curator of the Lepidoptera in the Paris Museum, 13, *rue Guy de la Brosse, Paris.*

1900 CHAMBERLAIN, Neville, *Westbourne, Edgbaston, Birmingham.*

1871 ‡ CHAMPION, George C., F.Z.S., A.L.S. (LIBRARIAN, 1891–1920; COUNCIL, 1875–7, 1921); *Bromhall-road, Horsell, Woking;* and 45, *Pont-street,* S.W. 1.

1914 ‡ CHAMPION, Harry George, B.A., Deputy Conservator of Forests, *Haldwani, U.P., India.*

1919 CHATTERJEE, Nibaran Chandra, B.Sc., *Forest Research Institute, Dehra Dun, U.P., India.*

1897 ‡ CHAWNER, Miss Ethel F., *Forest Bank, Lyndhurst S.O., Hants.*

1913 ‡ CHEAVIN, Capt. W. H. S., F.C.S., F.R.M.S., F.N.P.S., 19, *Rosendale-road, W. Dulwich, S.E.* 21

1919 CHEESMAN, Miss L. Evelyn, *Entomological Dept., Zoological Society, Regent's Park,* N.W. 8.

1920 ‡ CHEETHAM, Christopher Arthington, *Wheatfield, Old Farnley, Leeds.* All communications to *Stone Bridge Mills, Wortley, Leeds.*

1889 CHRISTY, William M., M.A., F.L.S., *Watergate, Emsworth.*

1914 CHRYSTAL, R. Neil, B.Sc., 1, *Morpeth Terrace, Westminster, S.W.* 1.

1909 CLARK, Lt.-Col. C. Turner, F.Z.S., *Hillcrest, St. Augustine's-avenue, S. Croydon.*

1914 CLEARE, L. D., *Govt. Economic Biologist, Dept. of Science and Agriculture, Georgetown, British Guiana.*

1914 CLEGHORN, Miss Maude Lina West, F.L.S., 12, *Alipore-road, Calcutta, India.*

1922 CLUTTEN, Wm. George, 136, *Coal Clough-lane, Burnley.*

1908 CLUTTERBUCK, Charles G., *Heathside,* 23, *Heathville-road, Gloucester.*

1908 CLUTTERBUCK, P. H., Inspector General of Forests, *Simla, India.*

1904 ‡ COCKAYNE, Edward A., M.A., M.D., F.R.C.P. (COUNCIL, 1915–17), 116, *Westbourne-terrace,* W. 2.

1920 COCKCROFT, T., 111, *Owen-street, Wellington South, New Zealand.*

1917 ‡ COCKERELL, Prof. T. D. A., *University of Colorado, Boulder, Colorado, U.S.A.*

1917 ‡ COCKS, Frederick, 42, *Crown-street, Reading.*

1914 COLEMAN, Leslie C., Dept. of Agriculture, *Bangalore, Mysore, India.*

1922 ‡ COLLENETTE, C. L., *Gothic Lodge, Woodford Green, Essex.*

1899 ‡ COLLIN, James E., VICE-PRESIDENT (V.-PRES., 1913; COUNCIL, 1904–6, 1913–15, 1922–), *Sussex Lodge, Newmarket.*

1918 COMSTOCK, Dr. John Adams, Director, South-Western Museum, *Marmion-way and Avenue, Los Angeles, California, U.S.A.*

1913 ‡ CONEY, Miss Blanche A., *Brampton Hall, Wangford, Suffolk.*

1919 ‡ Constable, Miss Florence B., *Datcha, Hookwood, Horley, Surrey.*
1921 Coote, F. D., 11, *Pendle-road, Streatham,* S.W.
1916 Cornford, The Rev. Bruce, 13, *Havelock-road, Portsmouth.*
1921 Corporaal, J. B., "*Natura Artis Magistra,*" *Amsterdam, Holland.*
1920 ‡ Cotterell, G. S., *Newlyn, Gerrard's Cross, Bucks.*
1913 Coward, Thomas Alfred, F.Z.S., 36, *George-street, Manchester.*
1923 ‡ Cox, L. G., 49, *Sussex-square, Brighton.*
1920 ‡ Crabbe, E., 52, *Sarsfield-road, Balham,* S.W. 12.
1895 Crabtree, Benjamin Hill, *Holly Bank, Alderley Edge, Cheshire.*
1913 Cragg, Major F. W., M.D., I.M.S., *Central Research Institute, Kasauli, Punjab, India.*
1919 Crampton, Prof. G. Chester, *Massachusetts Agricultural College, Amherst, Mass., U.S.A.*
1922 ‡ Crawford, Wm. Monod, B.A., *Orissa, Marlborough-park, Belfast.*
1909 ‡ Crawley, W. C., B.A., F.R.M.S. (Council, 1917–19), 29, *Holland Park-road,* W. 14.
1890 Crewe, Sir Vauncey Harpur, Bart., *Calke Abbey, Derbyshire.*
1907 ‡ Croft, Edward Octavius, M.D., 12, *North Hill-road, Headingley, Leeds.*
1919 ‡ Cumming, Bernard Douglas, *Whistman's Wood, West Clandon, Surrey.*
1908 Curtis, W. Parkinson, *Drake North, Sandringham-road, Parkstone, Dorset.*

1900 Dalglish, Andrew Adie, 7, *Keir-street, Pollokshields, Glasgow.*
1922 Daubenay, R. T., B.A., *Herne Vicarage, Herne, Kent.*
1911 Davey, H. W., *Cobungua,* 19, *Moama-road, E. Malvern, Australia.*
1913 ‡ Davidson, James, D.Sc., F.L.S. (Council, 1922–), *Institute of Plant Pathology, Rothamsted, Harpenden, Herts.*
1905 Davidson, James, 32, *Drumsheugh Gardens, Edinburgh.*
1912 Davis, Frederick Lionel, J.P., M.R.C.S., L.R.C.P., *Corozal, British Honduras.*
1910 ‡ Dawson, William George, *Shortlands House, Shortlands, Kent.*
1903 Day, F. H., 26, *Currock-terrace, Carlisle.*
1898 Day, G. O., *Sahlatston, Duncan's Station, Vancouver Island, British Columbia.*
1923 Dean, J. D., *Colin, Llandaff, Glam.*
1917 ‡ Dicksee, Arthur, 24, *Lyford-rd., Wandsworth Common,* S.W. 18.
1887 ‡ Dixey, Frederick Augustus, M.A., M.D., F.R.S., Fellow and Bursar of Wadham College (Pres., 1909–10; V.-Pres., 1904–5, 1911; Council, 1895, 1904–6), *Wadham College, Oxford.*
1921 Dobson, H. W., 14, *Finkle-street, Kendal.*
1909 † Dobson, Thomas, 33, *The Park, Sharples, Bolton.*
1905 Dodd, Frederick P., *Kuranda, viâ Cairns, Queensland.*
1912 ‡ Doig, Major Kenneth Alan Crawford, R.A.M.C., M.R.C.S., L.R.C.P., 3, *Hook Heath, Woking.*
1891 ‡ Donisthorpe, Horace St. John K., F.Z.S. (V.-Pres., 1911; Council, 1899–1901, 1910–12), *Durandesthorpe,* 19, *Hazlewell-road, Putney,* S.W. 15.

1921 Dover, C., 1, *Hopton-road, Streatham*, S.W.16.
1913 ‡ Dow, Walter James, 5, *Great College-street, Westminster*, S.W. 1.
1910 Downes-Shaw, Rev. Archibald, *Scotton Rectory, Gainsborough.*
1900 Drury, W. D., *Dorset House, St. Tobias-road, Sevenoaks.*
1921 du Porte, E. M., *Macdonald College, Quebec, Canada.*
1894 Dudgeon, G. C., C.B.E., 182, *Cromwell-road, S.W.* 7.
1913 Duffield, Charles Alban William, *Pickersden, Brook Ashford, Kent.*
1906 ‡ Dukinfield Jones, E., 118, *Fairview-avenue, Glendale, California, U.S.A.*
1883 ‡ Durrant, John Hartley (V.-Pres., 1912–13; Council, 1911–13, 1919–21), 20, *Burstock-road, Putney*, S.W. 15; and *British Museum (Natural History), Cromwell-road, S. Kensington*, S.W. 7.

1910 ‡ Eales-White, Capt. J. Cushny, 49, *Chester-terrace, Eaton-square*, S.W. 1.
1912 ‡ Earl, Herbert L., M.A., *Vanessa, Rawlyn-road, Torquay.*
1890–1914, 1922 Eastwood, John E., *Wade Court, Havant, Hants.*
1865 ‡ Eaton, The Rev. Alfred Edwin, M.A. (Council, 1877–9), *Richmond Villa, Northam S.O., N. Devon.*
1902 ‡ Edelsten, Hubert M., *The Elms, Forty-hill, Enfield, Middlesex.*
1919 Edwardes, Capt. Tickner, R.A.M.C., *The Red Cottage, Burpham, Arundel, Sussex.*
1911 ‡ Edwards, F. W., 56, *Norton road, Letchworth.*
1886 Edwards, James, *Colesborne, S.O., Glos.*
1884 ‡ Edwards, Stanley, F.L.S., F.Z.S. (Council, 1912–14), 15, *St. Germans-place, Blackheath*, S.E. 3.
1913 Edwards, William H., *Natural History Dept., The Museum, Birmingham.*
1916 ‡ Efflatoun, Bey Hassan, 38, *Shoubrah-avenue, Cairo, Egypt.*
1900 ‡ Elliott, E. A., 41, *Chapel Park-road, St. Leonards-on-Sea.*
1900 ‡ Ellis, H. Willoughby, F.Z.S. (Council, 1916–18, 1922–), 3, *Lancaster-place, Belsize Park*, N.W. 3.
1919 Elston, Albert H., "*Hatherley*," *Unley Park, S. Australia.*
1903 ‡ Eltringham, Harry, M.A., D.Sc., F.Z.S. (Secretary, 1922– ; V.-Pres., 1914, 1918; Council, 1913–15, 1918–20), *Woodhouse, Stroud, Gloucestershire*, and *Hope Department, University Museum, Oxford.*
1903 * Etheridge, Robert, *Curator, Australian Museum, Sydney, N.S.W.*
1908 Eustace, Eustace Mallabone, M.A., *Wellington College, Berks.*
1922 Evans, H. Silvester, M.R.C.S., L.R.C.P., *Lomaloma, Fiji.*
1919 ‡ Evans, Lt.-Col. Wm. Harry, D.S.O., R.E., c/o Messrs. Cox & Co., 16, *Charing Cross*, W.C. 2, and *H.Q. Northern Command, Murree, Punjab, India.*

1919 ‡ Falconer, William, 12, *King St., Waterloo, Liverpool.*
1907 Feather, Walter, *Cross Hills, nr. Keighley, Yorks.*

1900 ‡ Feltham, H. L. L., *Mercantile Buildings, Simmonds-street, Johannesburg, Transvaal.*

1861 ‡ Fenn, Charles, *Eversden House, Burnt Ash Hill, Lee,* S.E. 12.

1920 Fenton, Edward Wyllie, M.A., B.Sc., *Seale-Hayne Agricultural College, Newton Abbot, Devon.*

1918 ‡ Ferguson, Anderson, 22, *Polworth-gardens, Glasgow, W.*

1922 Fernald, H. T., Ph.D., *Mass. Agricultural College, Amherst, Mass., U.S.A.*

1900 Firth, J. Digby, F.L.S., *Boys' Modern School, Leeds.*

1898 ‡ Fletcher, Prof. T. Bainbrigge, R.N., *Agricultural Research Institute, Pusa, Bihar, India.*

1883 † Fletcher, William Holland B., M.A., *Aldwick Manor, Bognor.*

1905 Floersheim, Cecil, 16, *Kensington Court Mansions,* S.W. 8.

1922 Flower, Miss A. B., "*Eastbury,*" *Surrey-road, Bournemouth West.*

1914 Fordham, William John, M.R.C.S., L.R.C.P., D.Ph., *Whinney House, Low Fell, Gateshead.*

1913 Foster, Arthur H., M.R.C.S., L.R.C.P.(Eng.), M.B.O.U., 13, *Tile-house-street, Hitchin, Herts.*

1900 Foulkes, P. Hedworth, B.Sc., *Harper-Adams Agricultural College, Newport, Salop.*

1898 ‡ Fountaine, Miss Margaret E., 126, *Lexham Gardens,* W. 8.

1880‡*Fowler, The Rev. Canon, D.Sc., M.A., F.L.S. (Pres., 1901–2; V.-Pres., 1903; Sec., 1886–96), *Earley Vicarage, near Reading.*

1921 Fox, C. L., 1621, *Vallejo-street, San Francisco, California, U.S.A.*

1920 ‡ Fox-Wilson, G., *Entomological Dept., R.H.S. Laboratory, Wisley, Ripley, Surrey.*

1908 Fraser, Frederick C., Major, M.D., I.M.S., Civil Surgeon, *Mercara, Coorg, S. India.*

1888 ‡ Fremlin, H. Stuart, M.R.C.S., L.R.C.P., *Govt. Lymph Establishment, Colindale-avenue, The Hyde, London,* N.W. 9.

1921 Frew, J. G. H., *Emmanuel College, Cambridge.*

1910 ‡ Frisby, G. E., 29, *Darnley-road, Gravesend.*

1891 Frohawk, F. W., *c/o Dr. A. G. Butler, F.L.S., F.Z.S.,* 124, *Beckenham-road, Beckenham, Kent.*

1907 ‡ Fryer, John Claud Fortescue, M.A. (Council, 1916–18), *Milton-road, Harpenden, Herts.*

1876 ‡ Fuller, The Rev. Alfred, M.A., *The Lodge,* 7, *Sydenham-hill, Sydenham,* S.E. 26.

1887 ‡ Gahan, Charles Joseph, M.A., D.Sc. (Pres., 1917–18; V.-Pres., 1916, 1919; Sec., 1899–1900; Council, 1893–5, 1901, 1914–16, 1919), 8, *Lonsdale-road, Bedford Park,* W. 4; and *British Museum (Natural History), Cromwell-road,* S.W. 7.

1920 Gardner, J. C. M., *Forest Research Institute, Dehra Dun, U.P. India.*

1901†‡Gardner, Willoughby, F.L.S., F.S.A., *Deganwy, N. Wales.*

1923 Garrett, F. C., *West Croft, Hexham.*

1922 ‡ GATER, B. A. R., B.A., F.R.M.S., *Dept. of Agriculture, Kuala Lumpur, F.M.S.*

1920 GAUNTLETT, Harry Leon, F.Z.S., M.R.C.S., L.R.C.P., A.K.C., *Polygon House, Southampton.*

1913 ‡ DE GAYE, J. A., 35, *Perham-road, W. Kensington*, W. 14.

1919 ‡ GEDYE, Alfred Francis John, 59, *Westbourne Terrace*, W.2.

1923 GEE, G. F., *Springside, Mouldsworth, nr. Chester.*

1922 GHOSH, C. C., B.A., *Agricultural College, Mandalay, Burma, India.*

1915 ‡ GIBSON, Arthur, *Entomological Branch, Dept. of Agriculture, Ottawa, Canada.*

1908 GIFFARD, Walter M., *P.O. Box* 300, *Honolulu, Hawaii.*

1895 GILBERT-CARTER, Sir G. T., K.C.M.G., *c/o Cox, Biddulph & Co.*, 43, *Charing Cross*, S.W.

1907 GILES, Henry Murray 184, *Bennett St., East Perth, W. Australia.*

1904 ‡ GILLIAT, Francis, B.A., *Windham Club, St. James's-square, Piccadilly*, S.W. 1.

1919 ‡ GIMINGHAM, Conrad Theodore, O.B.E., F.I.C., *Rothamsted Experimental Station, Harpenden, Herts.*

1921 GLICK, P. A., *Arizona Commission of Agriculture and Horticulture, Phoenix, Arizona, U.S.A.*

1914 ‡ GODFREY, E. J., Education Dept., *Bangkok, Siam.*

1920 ‡ GOODBAN, Bernard Sinclair, *The Vicarage, Ewell, Surrey.*

1921 ‡ GOODMAN, O. R., "*Hatchgate*," *Massetts-road, Horley, Surrey.*

1904 GOODWIN, Edward, *Canon Court, Wateringbury, Kent.*

1898 ‡ GORDON, J. G. McH., *Corsemalzie, Whauphill S.O., Wigtownshire.*

1898 ‡ GORDON, R. S. G. McH., *Drumblair, Inverness.*

1913 GOUGH, Lewis, Ph.D., Entomologist to the Govt. of Egypt, *Dept. of Agriculture, Cairo.*

1909 GOWDEY, Carlton C., B.Sc., *Hope, Kingston P.O., Jamaica.* Transactions to 116, *Pleasant-street, Amherst, Mass., U.S.A.*

1918 GRACE, George, B.Sc., A.R.C.Sc., 23, *Alexander-crescent, Ilkley, Yorks.*

1914 GRAVELEY, F. H., *The Indian Museum, Calcutta.*

1911 ‡ GRAVES, Major P. P., *c/o* "*The Times*," *Printing House Square*, E.C.4.

1891 †‡GREEN, E. Ernest, F.Z.S., PRESIDENT (V.-PRES., 1915; COUNCIL, 1914–16), *Way's End, Beech-avenue, Camberley.*

1894 GREEN, J. F., F.Z.S., 49, *Draycott-place*, S.W. 3.

1922 GREENING, Linnaeus, F.L.S., F.Z.S., 33, *Wilson Patten-street, Warrington.*

1893 † GREENWOOD, Henry Powys, F.L.S., *Whitsbury House, Salisbury.*

1921 GREENWOOD, W. F. N., *C.S.R. Co., Lavtoka, Fiji.*

1920 GRIFFIN, J. W., 27, *The Summit, Liscard, Wallasey.*

1888 GRIFFITHS, G. C., F.Z.S., *Penhurst*, 3, *Leigh-road, Clifton, Bristol.*

1894 ‡ GRIMSHAW, Percy H., *Royal Scottish Museum, Edinburgh.*

1905 Grist, Charles J., *The Croft, Carol Green, Berkswill, Coventry.*
1920 ‡ Grosvenor, T. H. L., *Walldeanes, Redhill, Surrey.*
1920 ‡ Gunton, Major H. C., *Seaton Cottage, Gerrard's Cross Common, Bucks.*
1906 Gurney, Gerard H., *Keswick Hall, Norwich.*
1910 Gurney, William B., Govt. Entomologist, *Department of Agriculture, Sydney, Australia.*

1912 Hacker, Henry, *Queensland Museum, Brisbane, Queensland.*
1919 Hadwen, Dr. Seymour, D.Vet.Sci., 369, *Daly-avenue, Ottawa, Canada.*
1906 ‡ Hall, Arthur, "*Bowness,*" *Brighton-road, Purley, Surrey.*
1890*‡Hall, Albert Ernest, c/o *City Librarian, Surrey-street, Sheffield.*
1885 ‡ Hall, Thomas William, *Wood Grange, Shire-lane, Chorley Wood, Herts.*
1921 Hall, W. J., Entomologist, *Ministry of Agriculture, Cairo, Egypt.*
1912 Hallett, Howard Mountjoy, 64, *Westbourne-road, Penarth, Glamorganshire.*
1923 ‡ Halliwell, A. C., *St. Thomas's Hospital, Westminster,* S.W.
1915 Hamm, Albert Harry, 22, *Southfield-road, Oxford.*
1891 ‡ Hanbury, Frederick J., F.L.S., *Brockhurst, E. Grinstead.*
1923 ‡ Hancock, G. L. R., *Trinity College, Cambridge.*
1905 † Hancock, Joseph L., 5454, *University-avenue, Chicago. U.S.A.*
1923 Handley, G., 54, *All Saints'-rd., Kings Heath, Birmingham.*
1917 Harding, William G., F.L.S., M.R.S.I., F.R.H.S., *Kelly College, Tavistock, Devon.*
1903 ‡ Hare, E. J., 4, *New-square, Lincoln's Inn,* W.C. 2.
1920 ‡ Hargreaves, Ernest, *Imperial College of Science and Technology (Entomological Dept.), S. Kensington,* S.W. 7.
1920 Hargreaves, Harry, *Biological Laboratory, Kampala, Uganda.*
1921 Harland, S. C., D.Sc., *Shirley Institute, Didsbury, near Manchester.*
1910 ‡ Harwood, Philip, *St. Margaret's, Selby-avenue, St. Albans.*
1919 ‡ Hawker-Smith, William, *Speedwell Cottage, Hambledon, Godalming, Surrey.*
1913†‡Hawkshaw, Oliver, 3, *Hill-street, Mayfair,* W. 1.
1919 ‡ Hayward, H. C., M.A., *Repton, Derby.*
1921 ‡ Hayward, Capt. K. J., *The Vicarage, Bruton, Somerset.*
1910 ‡ van der Hedges, Alfred, *Overstone-court, Overstone, Northants.*
1919 ‡ Hemming, Capt. Arthur Francis, C.B.E., 57, *Stanhope Gardens,* S.W. 7
1910 Henderson, J., c/o *Messrs. Osborne & Chappel, Ipoh, Perak, Federated Malay States.*
1918 Herrod-Hempsall, Joseph, *Orchard House, Stockingstone-road, Luton, Beds.*

1903 Herrod-Hempsall, William, *W.B.C. Apiary, Old Bedford-road, Luton, Beds.*

1913 Hewitt, John, B.A., Director, *Albany Museum, Grahamstown, S. Africa.*

1923 Hicks, J. B., 99, *Barkston-gardens, S. Kensington*, S.W.

1922 ‡ Higgins, L. G., M.A., F.R.C.S., *Heatherside, Woking, Surrey.*

1907 ‡ Hoar, Thomas Frank Partridge, *Hillside, Verulam-road, St. Albans, Herts.*

1917 Hockin, John W., *Castle-street, Launceston.*

1920 Hodge, Albert Ernest, F.Z.S., 14, *Astonville-street, Southfields*, S.W. 18.

1914 Hodge, The Rev. Canon Edward Grose, *The Rectory, Birmingham.*

1912 Hodge, Harold, 99, *Highbury-place*, N. 5.

1888 Hodson, The Rev. J. H., B.A., B.D., *Rhyddington, Clifton Drive, Lytham.*

1902 Hole, R. S., *c/o Messrs. King and Co., Bombay.*

1910 Holford, H. O., *Elstead Lodge, Godalming, Surrey.*

1887 Holland, The Rev. W. J., D.D., Ph.D., Director Emeritus, *Carnegie Museum, Pittsburgh, Penn., U.S.A.*

1898 ‡ Holman-Hunt, C. B., F.Z.S., *Great Toller, nr. Dorchester, Dorset.*

1922 Hopkins, G. H. E., *Downing College, Cambridge.*

1921 Hopper, L. B., *Manor House, Penryn, Cornwall.*

1901 ‡ Hopson, Montagu F., L.D.S., R.C.S.Eng., F.L.S., 7, *Harley-street*, W. 1.

1919 de Horrack-Fournier, Mme., 90, *Boulevard Malesherbes, Paris*, and *Château de Voisins, Louveciennes, Seine et Oise. France.*

1907 † Howard, C. W., *Canton Christian College, Canton, China.*

1900 Howes, W. George, 259, *Cumberland-street, Dunedin, New Zealand.*

1888 Hudson, George Vernon, *Hill View, Karori, Wellington, New Zealand.*

1907 Hughes, C. N., 178, *Clarence Gate-gardens, Regent's Park*, N.W. 1.

1921 Hunt, Rev. T. Wesley, 116, *Cross-street, Kroonstadt, Orange Free State.*

1917 Hunter, David, M.A., M.B., *The Coppice, Nottingham.*

1922 ‡ Hutchinson, G. E., *Aysthorpe, Newton-road, Cambridge.*

1897 ‡ Image, Prof. Selwyn, M.A. (Council, 1909–11), 78, *Parkhurst-road, Camden-road*, N. 7.

1912†‡Imms, A. D., D.Sc., M.A., F.L.S. (V.-Pres., 1920; Council, 1919–21), *Rothamsted Experimental Station, Harpenden, Herts.*

1920 Inglis, Charles McFarlane, F.Z.S., M.B.O.U., *Baghownie Factory, Laheria Sarai, Bihar, India.*

1918 Isaacs, P. V., 2, *Gledhill-terrace, South Kensington*, S.W. 5.

1907 Jack, Rupert Wellstood, Government Entomologist, Department of Agriculture, *Salisbury, Rhodesia.*

1917 ‡ Jackson, Miss Dorothy J., *Swordale, Evanton, Ross-shire.*

1907 ‡ Jackson, P. H., 112, *Balham Park-road*, S.W. 12.

1922 Jackson, W. H., 14, *Woodcote Valley-road, Purley, Surrey.*

1920 James, Russell, 7, *Broadlands-road, Highgate*, N. 6.

1914 ‡ Janse, A. J. T., *1st-street, Gezina, Pretoria, S. Africa.*

1869 ‡ Janson, Oliver E., 44, *Great Russell-street, Bloomsbury*, W.C. 1; and *Cestria, Claremont-road, Highgate*, N. 6.

1898 Janson, Oliver J., 13, *Fairfax-road, Hornsey, N.*

1919 ‡ Jeans, Miss Gertrude M., *Penn Court*, 54, *Cromwell-road*, S.W. 7.

1886 Jenner, James Herbert Augustus, *East Gate House, Lewes.*

1909 Jepson, Frank P., *Peradeniya, Ceylon.*

1917 ‡ Jermyn, Col. Turenne, *Highcliffe, Weston-super-Mare.*

1886 John, Evan, *Llantrisant S.O., Glamorganshire.*

1907 Johnson, Charles Fielding, *West Bank, Didsbury-road, Heaton Mersey.*

1917 Johnson, Jesse, *c/o del Cónsul de Inglaterra, Guatemala City.*

1920 ‡ Johnstone, Douglas, *Brooklands, Rayleigh, Essex.*

1908 ‡ Joicey, James J., F.L.S., F.Z.S., F.R.G.S., etc. (Council, 1921–3), *The Hill, Witley, Surrey.*

1888 ‡ Jones, Albert H. (V.-Pres., 1912, 1918; Treas., 1904–17; Council, 1898–1900, 1918), *Church Gate House, Wadhurst, Sussex.*

1920 ‡ Jones, Rev. Neville, *Hope Fountain, Box* 283, *Bulawayo, Rhodesia, S. Africa.*

1894 † ‡ Jordan, Dr. K. (V.-Pres., 1909; Council, 1909–11), *The Museum, Tring.*

1910 ‡ Joseph, E. G., 23, *Clanricarde-gardens*, W. 2.

1910 ‡ Joy, Ernest Cooper, *Eversley, Dale-road, Purley.*

1902 ‡ Joy, Norman H., M.R.C.S., L.R.C.P., 78, *Crescent-road, Reading.*

1919 Jurriaanse, J. H., *W.Z. Schiekade*, 75, *Rotterdam, Holland.*

1911 Kannan, Kunhi, M.A., Asst. Entomologist to the Govt. of Mysore, *Bangalore, South India.*

1896 † ‡ Kaye, William James (Council, 1906–8), *Caracas, Ditton Hill, Surbiton.*

1890 ‡ Kenrick, Sir George H., *Whetstone, Somerset-road, Edgbaston, Birmingham.*

1920 Kent-Lemon, Capt. Arthur Leslie, York & Lancaster Regt., *c/o Postmaster, Khartoum, Sudan*, and *Blytheswood, Ascot, Berks.*

1904 Kershaw, G. Bertram, *Ingleside, West Wickham, Kent.*

1906 Keynes, John Neville, M.A., D.Sc., 6, *Harvey-road, Cambridge.*

1900 Keys, James H., 7, *Whimple-street, Plymouth.*

1919 Khare, Jagamath Laxman, Lecturer in Entomology, *Agricultural College, Nagpur, India.*

1912 ‡ King, Harold H., Govt. Entomologist, *Gordon College, Khartoum, Sudan.*

1889 ‡ KING, James J. F.-X., 1, *Athole Gardens-terrace, Kelvinside, Glasgow.*
1913 KIRBY, W. Egmont, M.D., *Hilden*, 46, *Sutton Court-road, Chiswick*, W. 4.
1917 ‡ KIRKPATRICK, Thos. W., *The Deanery, Ely*, and *Room* 270, *War Office, Whitehall*, S.W. 1.
1887 † KLEIN, Sydney T., F.L.S., F.R.A.S., *Lancaster Lodge, Kew Gardens, Surrey.*
1920 KNIGHT, V., *Fairgreen Cottage, Glemsford, Suffolk.*

1922 ‡ LACEY, Lionel, *Churchfields, Rodborough, Stroud, Glos.*
1916 ‡ LAING, Frederick (COUNCIL, 1922–), *Natural History Museum, Cromwell-road*, S.W. 7.
1910 ‡ LAKIN, C. Ernest, M.D., F.R.C.S., 105, *Harley-street*, W. 1.
1911†‡LAMBORN, W. A., M.R.C.S., L.R.C.P., *Littlemore, nr. Oxford.*
1921 ‡ LANCUM, F. H., 15, *Oakfield-lane, Dartford, Kent.*
1917 LANGHAM, Sir Charles, Bart., *Tempo Manor, Co. Fermanagh.*
1922 LANKESTER, C. H., *Cartago, Costa Rica.*
1920 LATHY, Percy I., 90, *Boulevard Malesherbes*, and 70, *Boulevard August Blaqui, Paris.*
1916 LATTA, Prof. Robert, D.Phil., *University of Glasgow.*
1895 LATTER, Oswald H., M.A., *Charterhouse, Godalming.*
1899 LEA, Arthur M., Government Entomologist, *Museum, Adelaide, S. Australia.*
1914 LEECHMAN, Alleyne, M.A., F.L.S., F.C.S., *Amani*, near *Tanga, Tanganyika Territory, East Africa.*
1910 LEIGH, H. S., *The University, Manchester.*
1900 LEIGH-PHILLIPS, Rev. W. J., *Burtle Vicarage, Bridgwater.*
1920 ‡ LEMAN, George Beddome Curtis, *Wynyard*, 52, *West Hill, Putney Heath*, S.W. 15.
1920 ‡ LEMAN, George Curtis, *Wynyard*, 52, *West Hill, Putney Heath*, S.W. 15.
1920 ‡ LEMAN, Sydney Curtis, *Wynyard*, 52, *West Hill, Putney Heath*, S.W. 15.
1903†‡LEVETT, The Rev. Thomas Prinsep, *Frenchgate, Richmond, Yorks.*
1876 ‡ LEWIS, George, F.L.S. (COUNCIL, 1878, 1884), 30, *Shorncliffe-road, Folkestone.*
1908 † LEWIS, John Spedan, 37, *Harley House, London*, N.W. 1.
1922 LIGHT, S. S., *Redcot, Linton-road, Hastings.*
1914 ‡ LISTER, J. J., *St. John's College, Cambridge*; and *Merton House, Grantchester, Cambs.*
1865 † LLEWELYN, Sir John Talbot Dillwyn, Bart., M.A., F.L.S. *Penllergare, Swansea.*
1881 † LLOYD, Alfred, F.C.S., *The Dome, Bognor.*
1919 ‡ LLOYD, Llewellyn, D.Sc., *Azare, Kano, N.P., Nigeria.*
1885†‡LLOYD, Robert Wylie (COUNCIL, 1900–1, 1923–), I, 5 and 6, *Albany, Piccadilly*, W. 1.
1920 ‡ LODGE, George, *Hawkhouse Park-road, Camberley.*

1903 Lofthouse, Thomas Ashton, *The Croft, Linthorpe, Middlesbrough.*

1908 ‡ Longsdon, D., *The Flower House, Southend, Catford,* S.E. 6.

1920 Loveridge, Arthur, *"St. Helena," Clevedon, Somerset.*

1893 Lower, Oswald B., *Broken Hill, New South Wales, Australia.*

1901 Lower, Rupert S., *Tranmere, Magill-road, Canyton, S. Australia.*

1923 Lowther, R. C., M.B., Ch.B., *Fernleigh, Grange-over-Sands, Lancs.*

1898 ‡ Lucas, William John, B.A. (Council, 1904–6), 28, *Knight's-park, Kingston-on-Thames.*

1903 Lyell, G., *Gisborne, Victoria, Australia.*

1912 ‡ Lyle, George Trevor, *Briarfield, Stump Cross, Shibden, Halifax.*

1909 Lyon, Francis Hamilton, *Silversundsvagen* 29, *Helsingfors-Bräuds, Finland.*

1922 McConnell, Dr. R. E., *Arua, Uganda.*

1910 Macdougall, Professor R. Stewart, M.A., D.Sc., F.R.S.E., 9, *Dryden Place, Blacket Avenue, Edinburgh.*

1922 ‡ Mace, Herbert, *Faircotes, Harlow, Essex.*

1919 McLeod, Murdoch Campbell, *The Fairfields, Cobham, Surrey,* and *c/o McLeod & Son, Calcutta, India.*

1900 Mackwood, The Hon. F. M., M.L.C., *c/o Cotesworth & Powell, Ltd.,* 9, *Wood-street,* E.C. 2.

1899†‡Main, Hugh, B.Sc. (Council, 1908–10), *Almondale,* 55, *Buckingham-road, South Woodford,* N.E.

1905 Mally, Charles William., M.Sc., *Dept. of Agriculture, Cape Town, S. Africa.*

1892 ‡ Mansbridge, William, *Dunraven, Church-road, Wavertree, Liverpool.*

1919 Mansfield-Aders, Dr. W., *Zanzibar.*

1920 Marriner, Thomas Frederic, 2, *Brunswick-street, Carlisle.*

1895 ‡ Marshall, Guy Anstruther Knox, C.M.G., D.Sc., F.R.S., F.Z.S. (V.-Pres., 1919; Council, 1907–8, 1919–21), 6, *Chester-place, Hyde Park-square,* W. 2.

1922 Marshall, J. F., M.A., F.Z.S., *Seacourt, Hayling Island, Hants.*

1896 Marshall, P., M.A., B.Sc., F.G.S., *New Zealand University, Wellington, New Zealand.*

1897 Martineau, Alfred H., *Shutteroaks Toll House, Crewherne, Somerset.*

1919 Marumo, N., *Zoological Institute, Agricultural College, Imperial University, Komaba, Tokyo, Japan.*

1922 ‡ Massee, A. M., *Park-place, The Common, Sevenoaks, Kent.*

1895 Massey, Herbert, *Ivy-Lea, Burnage, Didsbury, Manchester.*

1865 Mathew, Gervase F., F.L.S., Paymaster-in-chief, R.N. (Council, 1887), *Lee House, Dovercourt, Harwich.*

1921 Matsumura, Prof. S., *Hokkaido Imperial University, Sapporo, Japan.*

1887 Matthews, Coryndon, *Woodside, Salcombe, S. Devon.*

1912 Maulik, Prof. S., *Dept. of Zoology, University of Calcutta, Calcutta, India.*

1900 ‡ Maxwell-Lefroy, Professor H., *Imperial College of Science and Technology, South Kensington*, S.W

1916 ‡ May, Harry Haden, *Black Friars Distillery, Southside-street, Plymouth.*

1913 ‡ Meaden, Louis, *Melbourne, Dyke-road, Preston, Brighton.*

1920 ‡ Meldola, Mrs. Ella Frederica, 6, *Brunswick-square*, W.C. 1.

1919 Mellows, Charles, M.A., *The College, Bishop's Stortford.*

1885 Melvill, James Cosmo, M.A., F.L.S., *Meole Brace Hall, Shrewsbury.*

1887 ‡ Merrifield Frederic (Pres., 1905–6 ; V.-Pres., 1893, 1907 ; Sec., 1897–8 ; Council, 1894, 1899), 14, *Clifton-terrace, Brighton.*

1912 Metcalfe, Rev. J. W., *St. Luke's House, Torquay.*

1880 ‡ Meyrick, Edward, B.A., F.R.S., F.Z.S., *Thornhanger, Marlborough.*

1919 Miles, Herbert William, N.D.A., *The Gardens, Lydney Park, Gloucester.*

1883 ‡ Miles, W. H., *c/o E. Step, Esq.*, 158, *Dora-road, Wimbledon Park*, S.W. 19.

1920 Miller, D., 71, *Fairlie Terrace, Kelburn, Wellington, New Zealand.*

1921 Miller, N. E., *Tukuyu, Tanganyika Territory, E. Africa.*

1923 Millward, G. D., 32, *Moorgate*, E.C. 2.

1905 ‡ Mitford, Robert Sidney, C.B., 9, *Beaconsfield-terrace, Hythe, Kent.*

1902 ‡ Montgomery, Arthur Meadows, 36, *Twyford-avenue, Acton*, W. 3.

1922 ‡ Moore, A., M.D., *Sundew, Lyndhurst, Hants.*

1922 ‡ Moore, A. E., *Brookside, Brent Mead-avenue, Golders Green*, N.W. 3.

1899 ‡ Moore, Harry, 12, *Lower-road, Rotherhithe*, S.E. 16.

1922 Moore, J. W., 151, *Middleton Hall-road, King's Norton, Birmingham.*

1886 Morgan, A. C. F., F.L.S., 135, *Oakwood-court, Kensington*, W. 14.

1889 † ‡ Morice, The Rev. F. D., M.A., F.Z.S., Fellow of Queen's College, Oxford (Pres., 1911–12 ; V.-Pres., 1902, 1904, 1913, 1919 ; Council, 1902–4, 1918–20), *Brunswick, Mount Hermon, Woking.*

1895 † ‡ Morley, Claude, F.Z.S., *Monk Soham House, Suffolk.*

1920 ‡ Morris, Hubert Meridydd, M.Sc., *Institute of Plant Pathology, Rothamsted Experimental Station, Harpenden, Herts.*

1893 Morton, Kenneth J., 13, *Blackford-road, Edinburgh.*

1910 ‡ Mosely, Martin E., 94, *Campden Hill-road, Kensington*, W. 8.

1882 Mosley, S. L., *Ravensknowle Museum, Huddersfield.*

1911 ‡ Moss, Rev. A. Miles, *c/o Messrs. Booth & Co., Para, Brazil.*

1907 † ‡ Moulton, John C., O.B.E., M.A., B.Sc., F.Z.S., etc., *Kuching, Sarawak* (via *Singapore*).

1911 Mounsey, J. Jackson, *Bryn-Tirion, Kingstone, Hereford.*

1922 ‡ Moysey, Capt. Francis, *c/o Col. R. H. Rattray*, 68, *Dry Hill Park-road, Tonbridge, Kent.*

1901 † ‡ Muir, Frederick, *H.S.P.A. Experiment Station, Honolulu, Oahu, H.I.*

1912 † MULLAN, Jal Phirozshah, M.A., F.L.S., F.Z.S., Professor of Biology, *St. Xavier's College, Lamington-road, Grant Road Post, Bombay, India.*

1920 MUNRO, Hugh Kenneth, B.Sc., *P.O. Box* 16, *East London, South Africa.*

1918 MUNRO, James W., D.Sc., *Green Lawn, Kew-road, Richmond, Surrey.*

1914 MURRAY, George H., *The Residency, Kerema Gulf Division, Papua.*

1917 MUSCHAMP, Percy A. H., 35, *Upperton-road, Leicester.*

1922 MUSGRAVE, A., *Australian Museum, Sydney, N.S.W.*

1909 MUSHAM, John F., 48, *Brook-street, Selby, Yorks.*

1920 MYERS, J. G., 71, *Fairlie-terrace, Kelburn, Wellington, N.Z.*

1921 NAIR, K. P. U., *Training College, Trivandrum, India.*

1903 ‡ NEAVE, S. A., M.A., D.Sc., F.Z.S. (SECRETARY, 1919- ; V.-PRES., 1918 ; COUNCIL, 1916–18), 41, *Queen's Gate*, S.W. 7, and *Bishop's House, Beaconsfield, Bucks.*

1919 ‡ NELL, Louis, *Imperial Bureau of Entomology*, 41, *Queen's Gate*, S.W. 7.

1919 NELSON, William George Frazer (COUNCIL, 1922–), 6, *Bolton Street, Piccadilly*, W. 1.

1901 ‡ NEVINSON, E. B., *Morland, Cobham, Surrey.*

1923 ‡ NEWLAND, GORDON, 19, *Bath-road, Bradford Park*, W. 4.

1907 ‡ NEWMAN, Leonard Woods, *Bexley, Kent.*

1913 NEWMAN, Leslie John William, *Bernard-street, Claremont, W. Australia.*

1909 NEWSTEAD, Alfred, *The Grosvenor Museum, Chester.*

1890 ‡ NEWSTEAD, Prof. Robert, M.Sc., F.R.S., A.L.S., Hon. F.R.H.S., Dutton Memorial Professor of Entomology, *The School of Tropical Medicine, University of Liverpool.*

1921 NICHOLSON, A. J., *University of Sydney, New South Wales, Australia.*

1914 ‡ NICHOLSON, Charles, 35, *The Avenue, Hale-end, Chingford*, E. 4.

1909 ‡ NICHOLSON, Gilbert W., M.A., M.D. (COUNCIL, 1913–15), *Oxford and Cambridge Club, Pall Mall*, S.W. 1.

1918 ‡ NIMMY, Ernest William, 210, *Whippendell-road, Watford, Herts.*

1906 NIX, John Ashburner, *Tilgate, Crawley, Sussex.*

1914 NORRIS, Frederic de la Mare, *The Agricultural Department, Kuala Lumpur, Federated Malay States.*

1915 NORTHCOTE, Dr. A. B., 4, *Columbia-road, Bethnal Green*, E. 2.

1923 NOTMAN, H., F.S.A., 136, *Joralemon-st., Brooklyn, New York.*

1895 NURSE, Lt.-Colonel C. G., *Redcote, Rusthall Park, Tunbridge Wells.*

1877 OBERTHÜR, René, *Rennes* (*Ille-et-Vilaine*), *France.*

1910 ‡ OLDAKER, Francis A., M.A., *The Red House, Haslemere.*

1921 Ollenbach, O. C., *Survey of India Dept., Dehra Dun, India.*
1913 ‡ Ormiston, Walter, *Kalupatrani, Haldummulle, Ceylon.*

1895 ‡ Page, Herbert E. (Council, 1918–20), *Bertrose, Gellatly-road, St. Catherine's Park*, S.E. 15.
1921 Pallis, M. A., *Tatoi, Aigburth Drive, Liverpool.*
1916 Palmer, A. Ray, *Standeford, Baldock-road, Letchworth, Herts.*
1919 Paravicini, Louis, *Commissioner de la Bourse de Bâle, Bâle, Switzerland.*
1918 ‡ Parris, R. Stanway, *The Gables, Sandhurst, Berks.*
1919 Patton, Major W. S., I.M.S., 34, *York-road, Trinity, Edinburgh.*
1922 ‡ Pearce, Edmund J., *The Lodge, Corpus Christi College, Cambridge.*
1922 ‡ Pearce, Miss E. K., *Kempston. Bournemouth West.*
1911 ‡ Pearson, Douglas, *Chilwell House, Chilwell, Notts.*
1916 ‡ Peebles, Howard M., 71, *Cadogan Gardens*, S.W. 3.
1919 Peed, John, *Aylesham, Norfolk.*
1915 ‡ Peile, Lt.-Col. Harry Diamond, I.M.S., *Grove House, De la Warr-road, Bexhill-on-Sea.*
1921 ‡ Pendlebury, H. M., *Broadlands, Shrewsbury*; Systematic Entomologist, *Federated Malay States.*
1914 ‡ Pendlebury, Wm. J. von Monté, M.A., *Broadlands, Shrewsbury.*
1883 Péringuey, Louis, D.Sc., F.Z.S., Director, *South African Museum, Cape Town, South Africa.*
1922 ‡ Perkins, M. G. L., 4, *Dean's-yard, Westminster-abbey*, S.W. 1.
1903 † Perkins, R. C. L., M.A., D.Sc., F.Z.S., *Park Hill House, Paignton, Devon;* and Board of Agriculture, Division of Entomology, *Honolulu, Hawaii.*
1907 † Perrins, J. A. D., 3rd Seaforth Highlanders, *Davenham, Malvern.*
1897 ‡ Phillips, Capt. Hubert C., F.Z.S., M.R.C.S., L.S.A., 17, *Hereford-road, Bayswater*, W. 2.
1903†‡Phillips, Montagu A., F.R.G.S., F.Z.S., *c/o Dr. Phillips*, 57, *St. George's-square*, S.W.
1920 Philpott, A., Assistant Entomologist, Biological Dept., *Cawthron Institute of Scientific Research, Nelson, New Zealand.*
1922 ‡ Piazza, E., 4734, *48th-street, St. San Diego, California, U.S.A.*
1917 ‡ Pickard-Cambridge, Arthur W., M.A., *Balliol College, Oxford.*
1891 ‡ Pierce, Frank Nelson, *The Old Rectory, Warmington, Oundle, Northants.*
1913 Platt, Ernest Edward, 403, *Essenwood-road, Durban, Natal.*
1885 Poll, J. R. H. Neerwort van der, *c/o J. Stroeve, B.Z. Prinsengracht*, 1005, *Amsterdam.*
1919 Pomeroy, Arthur W. Jobbins, Government Entomologist in Nigeria, *Ibadan, S. Nigeria.*
1870†‡Porritt, Geo. T., F.L.S. (Council, 1887), *Elm Lea, Dalton, Huddersfield.*

1884 † ‡ POULTON, Professor Edward B., D.Sc., M.A., F.R.S., F.L.S., F.G.S., F.Z.S., Hope Professor of Zoology in the University of Oxford, VICE-PRESIDENT (PRES., 1903–4; V.-PRES., 1894–5, 1902, 1905, 1922; COUNCIL, 1886–8, 1892, 1896, 1905–7, 1922), *Wykeham House, Banbury-road, Oxford.*

1905 POWELL, Harold, 7, *Rue Mireille, Hyères (Var), France.*

1921 POWNIAH, D., *Agricultural Dept., Kuala Lumpur, Fed. Malay States.*

1919 PRAED, Cyril Winthrop Mackworth, *Dalton Hill, Albury, Surrey.*

1878 PRICE, David, 12, *Worthing-road, Horsham.*

1922 PRICE, J., 165, *Corporation-street, Stafford.*

1908 ‡ PRIDEAUX, Robert M. (COUNCIL, 1917), *Woodlands, Brasted Chart, Sevenoaks.*

1920 ‡ PRIOR, W. H. T., *Culban, Main-road, New Eltham, Kent.*

1904 ‡ PRISKE, Richard A. R., 9, *Melbourne Avenue, West Ealing.*

1920 PROUT, Miss Alice Ellen, *Lane End, Hambledon, Surrey.*

1893 ‡ PROUT, Louis Beethoven (COUNCIL, 1905–7), 84, *Albert-road, Dalston,* E. 8.

1910 PUNNETT, Professor Reginald Crundall, M.A., *Caius College, Cambridge.*

1922 ‡ RAE, Mrs. Margaret, *Courthill, Birkenhead.*

1923 ‡ RAFF, Miss Janet W., M.Sc., *c/o The Biology School, University of Melbourne, Victoria, Australia.*

1912 ‡ RAIT-SMITH, W., *Birkby House, Bickley Park, Kent.*

1914 RAMAKRISHNA, T. V. Ayyar, B.A., F.Z.S., *The Agricultural College, Coimbatore, S. India.*

1920 ‡ RAMBOUSEK, Dr. F. G., M.P., vii/1169, *Prague, Czechoslovakia.*

1913 RAO, K. Ananthaswamy, *Curator of the Government Museum, Bangalore, India.*

1916 RAO, Yelseti Ramachandra, M.A., *Agricultural College, Coimbatore, India.*

1920 RAYMUNDO, Prof. Benedicto, Director of the Agricultural Society's Museum, 76, *rua Senador Alencar, Rio di Janeiro, Brazil.*

1907 ‡ RAYWARD, Arthur Leslie, *c/o T. N. Rayward, Esq., The Glen, Wraxall, nr. Bristol.*

1898 REUTER, Professor Enzio, *Helsingfors, Finland.*

1910 ‡ DE RHÉ-PHILIPE, G. W. V., Chief Examiner of Accounts, North-Western Ry., *Abbott-road, Lahore, India.*

1921 RHODES, F., *Corporation Art Gallery and Museum, Cartwright Memorial Hall, Lister Park, Bradford.*

1920 ‡ RHYNEHART, John George, A.R.C.Sc.I., N.D.A., *Ministry of Agriculture, Wellington Place, Belfast.*

1920 ‡ RICHARDS, Philip Bernard, 7, *Churchways Crescent, Horfield, Bristol.*

1920 ‡ RICHARDSON, Arthur Walter, 28, *Avenue-road, Southall, Middlesex.*

1922 RICHARDSON, Rev. W. H., 32, *Wanderers Avenue, Wolverhampton.*

1921 RIDDELL, Miss J., Y.W.C.A., 251, *So. Hill-street, Los Angeles, California, U.S.A.*

1912 ‡ Riley, Capt. Norman Denbigh (Council, 1921–23), 5, *Brook Gardens, Beverley-road, Barnes*, S.W. 13, and *British Museum (Natural History), S. Kensington*, S.W. 7.

1908 ‡ Rippon, Claude, M.A., 28, *Springfield House, Abingdon.*

1917 Roberts, A. W. Rymer, M.A., *Molteno Institute, Cambridge.*

1905 Robinson, Herbert C., *Curator of State Museum, Kuala Lumpur, Selangor.*

1904 ‡ Robinson, Lady, *Worksop Manor, Notts.*

1921 Roebuck, A., *Midland Agricultural and Dairy College, Sutton Bonnington, Loughborough.*

1908 ‡ Rogers, The Rev. Canon K. St. Aubyn, M.A., *Box* 395, *Nairobi, Kenya Colony.*

1922 Rosa, A. F., M.D., 28 *Pitt-street, Edinburgh.*

1907 ‡ Rosenberg, W. F. H., 57, *Haverstock-hill*, N.W. 3.

1888†‡Rothschild, The Right Hon. Lord, D.Sc., F.R.S., F.L.S., F.Z.S., Vice-President (Pres., 1921–22; V.-Pres., 1920; Council, 1900, 1919), *Zoological Museum, Tring.*

1894*‡Rothschild, The Hon. Nathaniel Charles, M.A., F.L.S., F.Z.S. (Pres., 1915–16; V.-Pres., 1914, 1917; Council, 1904, 1913–17), *Arundel-house, Kensington Palace Gardens*, W. 8.

1890 ‡ Routledge, G. B., *Tarn Lodge, Heads Nook, Carlisle.*

1922 Russell, Frank, *Auldham House, Worksop.*

1892 ‡ Russell, S. G. C., *Roedean, The Avenue, Andover.*

1922 Ruston, A. H., *Aylesbury House, Chatteris, Cambs.*

1922 Ryle, G. B., *Pangbourne, Berks.*

1919 ‡ St. Aubyn, Capt. John G., c/o Sir Charles McGrigor & Co., 39, *Panton-street, Haymarket*, S.W. 1.

1920 St. John, W. St. A., M.R.C.S., L.R.C.P., *Derwent House, Derby.*

1906 Sampson, Colonel F. Winn, 115, *Tannsfield-road, Sydenham.*

1910 ‡ Saunders, H. A., *St. Ann's, Reigate.*

1923 Saunders, L. G., B.Sc., *Molteno Institute, Cambridge.*

1920 Scharff, J. W., *London School of Tropical Medicine, Endsleigh Gardens*, N.W.

1901 Schaus, W., F.Z.S., *U.S. National Museum, Washington, D.C., U.S.A.*, 1737, *High-street, Washington, D.C.*

1920 Schlupp, W. F., B.Sc., *School of Agriculture & Experimental Station, Potchefstroom, Transvaal.*

1907 ‡ Schmassmann, W., *Beulah Lodge, London-road, Enfield*, N.

1912 Schunck, Charles A., *Ewelme, Wallingford.*

1909 ‡ Scott, Hugh, M.A., D.Sc., Curator in Entomology, *University Museum of Zoology, Cambridge.*

1920 ‡ Seabrook, J., *Effingham Lodge, Surbiton Crescent, Surbiton, Surrey.*

1911 Selous, Cuthbert F., M.D., M.R.C.S., L.R.C.P., 25, *Church-road, Tunbridge Wells.*

1911†‡Sennett, Noel Stanton, 24, *de Vere-gardens, Kensington*, W. 8.

1915 Shaw, Dr. A. Eland, c/o R. Kelly, Esq., Solicitor, 59, *Swanston-street, Melbourne, Victoria, Australia.*

1886 Shaw, George T. (Librarian of the Liverpool Free Public Library), *William Brown-street, Liverpool.*

1905 ‡ Sheldon, W. George, F.Z.S. (Treasurer, 1918– ; Vice-President, 1920), *West Watch, Limpsfield, Surrey.*

1900 † ‡ Shepheard-Walwyn, H. W., M.A., *Dalwhinnie, Kenley, Surrey.*

1923 Sherman, J. D., Jun., 132, *Primrose-avenue, Mt. Vernon, New York, U.S.A.*

1921 Shroff, K. D., *Kelapith,* 22, *Oxford Road, Putney, S.W.*

1887 † ‡ Sich, Alfred (Council, 1910–12), *Corney House, Chiswick,* W. 4.

1911 ‡ Simes, James A., *Kingsley Cottage, Queen's-road, Loughton, Essex.*

1904 ‡ Simmonds, Hubert W., *Sussex View, Cumberland-gardens, Tunbridge Wells.*

1921 ‡ Simms, H. M., B.Sc., *The Farlands, Stourbridge.*

1920 ‡ Skaife, George Harold, M.A., *Inspector of Science, Department of Education, Cape Town, South Africa.*

1922 Sloane, T. G., *Moorilla, Young, New South Wales, Australia.*

1906 ‡ Smallman, Raleigh S., *Heathersett,* 30. *Leigham Court-road, Streatham,* S.W. 16.

1916 Smart, Major H. Douglas, M.D., B.S., *Shelley, Huddersfield.*

1920 ‡ Smee, C., *Govt. Entomologist, Zomba, Nyasaland.*

1915 ‡ Smith, Adam Charles, *Horton, Mornington-road, Woodford Green.*

1901 Smith, Arthur, *County Museum, Lincoln.*

1911 ‡ Smith, B. H., B.A., *Frant Court, Frant, Tunbridge Wells.*

1918 Smith, Patrick Aubrey Hugh, *Sconner House, St. German's, Cornwall.*

1912 ‡ Smith, Roland T., 131, *Queen's-road, Wimbledon,* S.W. 19.

1919 Smith, S. Gordon, F.L.S., *Estyn, Boughton, Cheshire.*

1918 † Smith, William Proctor, F.Z.S., *Haddon House, Ashton-on-Mersey.*

1885 ‡ South, Richard (Council, 1890–1), 4, *Mapesbury-court, Shoot-up Hill, Brondesbury,* N.W. 2.

1916 ‡ Sowerby, F. W., *Sea View, Little Haven, Pembrokeshire.*

1908 ‡ Speyer, Edward R., *Ridgehurst, Shenley, Herts.*

1919 ‡ Staniland, L. N., *Trewint, Coppett's-road, Muswell Hill,* N. 10.

1910 Stanley, The Rev. Hubert George, *Marshfield Vicarage, Cardiff.*

1919 Stansfield, Capt. Leslie Rawdon, R.G.A., *c/o Army and Navy Club, Pall Mall,* S.W. 1.

1910 ‡ Stenton, Rupert, *Ministry of Agriculture, Milton-road, Harpenden, Herts.*

1923 Stewart, A. M., 8, *Ferguslie, Paisley, N.B.*

1922 Stewart, B., *Lovell House, Leeds, Yorks.*

1920 ‡ Stidstone, Engineer-Commander S. T., R.N., *H.M.S. Woolwich, Devonport.*

1918 ‡ Stiff, Rev. Alfred T., *All Souls' Vicarage, Brighton.*

1910 ‡ Stoneham, Hugh Frederick, Capt., *4th Batt. The King's African Rifles, Bombo, Uganda, British East Africa.*

1915 ‡ Stott, Charles Ernest, *Eaton, London-road, Reigate.*

1896 ‡ Strickland, T. A. Gerald, *Southcott, Poulton, Fairford.*

1919 Susainathan, P., Assistant in Entomology, *College of Agriculture and Research Institute, Coimbatore, S. India.*

1884 * Swinhoe, Colonel Charles, M.A., F.L.S., F.Z.S. (V.-Pres., 1894; Council, 1891–3; 1902–4), 4, *Gunterstone-road, West Kensington*, W. 14.

1876 ‡ Swinton, A. H., *Oak Villa, Braishfield, Romsey, Hants.*

1911 ‡ Swynnerton, C. F. M., *Kilosa, Tanganyika Territory.*

1920 ‡ Syms, Edgar E., 22, *Woodlands-avenue, Wanstead*, E. 11.

1910 Tait, Robt., junr., *Covertside, Moss Lane, Ashton-on-Mersey.*

1908 ‡ Talbot, G., *Mon Plaisir, Wormley, Surrey.*

1920 ‡ Tams, W. H., 19, *Sullivan Road, Hurlingham, S.W.* 6.

1918 Tapp, Capt. William Henry, F.R.A.S., F.R.G.S., 12, *Heddon-street, Regent-street*, W. 1.

1916 Tatchell, Leonard Spencer, *Swanage, Dorset.*

1911 Taylor, Frank H., *Box* 137, *G.P.O., Sydney, N.S.W.*

1903 Taylor, Thomas Harold, M.A., *Yorkshire College, Leeds.*

1914 Temperley, Reginald, *The Manor House, Merricott, Somerset.*

1919 ‡ Temple, Major Watkin, *East Mersea, Essex.*

1910 ‡ Theobald, Prof. F. V., M.A., *Wye Court, Wye, Kent.*

1901 Thompson, Matthew Lawson, 40, *Gosford-street, Middlesbrough.*

1892 Thornley, The Rev. A., M.A., F.L.S., *Royal Agricultural College, Cirencester.*

1907 ‡ Tillyard, Robin John, M.A., D.Sc., F.L.S., Chief of the Biological Dept., *Cawthron Inst. of Scientific Research, Nelson, New Zealand*, and *Maitai Lodge, Bridge-street, Nelson, N.Z.*

1920 Tinsley, Joseph, *West of Scotland Agricultural College, Burns-avenue, Kilmarnock.*

1911 ‡ Todd, R. G., 54, *Hornsey-lane, Highgate*, N. 6.

1897 Tomlin, J. R. le B., M.A. (Council 1911–13), 23, *Boscobel-road, St. Leonards-on-Sea.*

1907 ‡ Tonge, Alfred Ernest (Council, 1915–17), *Aincroft, Reigate, Surrey.*

1920 Tonge, Alfred E., *Ashville, Trafford-road, Alderley Edge, Cheshire.*

1914 de la Torre Bueno, J. R., 11, *North Broadway, White Plains, New York, U.S.A.*

1911 ‡ Tower, P. H., 14, *Clifford-street, Bond-street*, W.

1922 Treherne, R. C., *Dept. of Agriculture, Ottawa, Canada.*

1919 Tullett, Austin Augustus, 50, *Oxford-street, Whitstable.*

1906 ‡ Tulloch, Col. J. B. G., C.B., C.M.G., *Head Quarters, Western Command, Chester.*

1895 ‡ Tunaley, Henry, *Castleton, Searle-road, Farnham.*

1910 Turati, Conte Emilio, 4, *Piazza S. Alessandro, Milan, Italy.*

1898 ‡ Turner, A. J., M.D., *Wickham Terrace, Brisbane, Australia.*

1893 ‡ TURNER, Henry Jerome (LIBRARIAN, 1921– ; COUNCIL, 1910–12), 98, *Drakefell-road, New Cross*, S.E. 14.

1906 ‡ TURNER, Rowland E. (COUNCIL, 1909–10), *British Museum (Natural History), S. Kensington*, S.W. 7.

1921 TUTT, J. F. D., M.R.C.V.S., F.R.M.S., F.Z.S., F.L.S., 1, *St. Cross-road, Winchester, Hants.*

1923 ‡ TWIDLE, A., N.S.A., *The Rowans, Godstone Green, Surrey.*

1915 TYTLER, Brigadier-Gen. H. C., C.M.G., C.S.I., D.S.O., *Delhi, India.*

1893 ‡ URICH, Frederick William, C.M.Z.S., *Port of Spain, Trinidad, British West Indies.*

1920 ‡ UVAROV, B., *Natural History Museum, S. Kensington*, S.W. 7.

1922 ‡ VAN SOMEREN, V. G. L., C.M.Z.S., M.B.O.U., *Nairobi, Kenya Colony.*

1904 † ‡ VAUGHAN, W., *The Old Rectory, Beckington, Bath.*

1914 ‡ VEITCH, Robert, B.Sc., Entomologist, c/o C.S.R. Co., *Lantoka Mills, Lantoka, Fiji Islands.*

1909 VIDLER, Leopold A., *The Carmelite Stone House, Rye.*

1911 VITALIS DE SALVAZA, R., *Boite Postale, No.* 61, *Saigon, Cochinchine.*

1897 ‡ WAINWRIGHT, Colbran J. (COUNCIL, 1901, 1912–14), *Daylesford, Handsworth Wood, Birmingham.*

1918 WALFORD, Lionel Julian, *The Cavalry Club, Piccadilly*, W.

1878 ‡ WALKER, James J., M.A., R.N., F.L.S. (PRESIDENT, 1919–20; V.-PRES., 1916, 1921; SEC., 1899, 1905–1918; COUNCIL, 1894, 1921), *Aorangi, Lonsdale-road, Summertown, Oxford.*

1921 WALKER, S., 53, *Micklegate Hill, York.*

1912 WALLACE, Henry S., c/o R. S. Bagnall & Sons, Ltd., 15, *Grey-street, Newcastle-on-Tyne.*

1920 WALLACE, William, M.B., 15, *Hainton-avenue, Grimsby.*

1921 WALLIS, H. H., M.A., *Rye Grammar School, Rye, Sussex.*

1920 WALTERS, Owen Huth, *Kulu, Punjab, India.*

1919 ‡ WARD, James Davis, *Limehurst, Grange-over-Sands, Lancs.*

1910 ‡ WARD, John J., *Rusinurbe House, Somerset-road, Coventry.*

1908 ‡ WARREN, Brisbane C. S., 14, *Avenue de l'Eglise Anglaise, Lausanne, Switzerland.*

1901 † WATERHOUSE, Gustavus Athol, B.Sc., B.E., *Allowrie, Stanhope-road, Killara, New South Wales, Australia.*

1923 ‡ WATERS, E. G. R., M.A., 40, *Leckford-road, Oxford.*

1914 ‡ WATERSTON, James, B.D., D.Sc. (COUNCIL, 1920–22), 21, *Arlington Park-mansions, Chiswick*, W. 4; and *British Museum (Natural History), S. Kensington*, S.W. 7.

1921 WATKINSON, The Rev. G. M. A., *Woodfield, Hipperholme, near Halifax.*

1919 ‡ WATSON, E. B., *The Grange, Winthorpe, Newark.*

1918 WATSON, John Henry, 70, *Ashford-road, Withington, Manchester.*

1914 Watt, Morris N., *St. John's Hill, Wanganui, New Zealand.*

1923 West, Lieut.-Col. R. M., M.D., D.S.O., O.B.E., *Wootton Bridge, Isle of Wight.*

1906 ‡ Wheeler, The Rev. George, M.A., F.Z.S. (Secretary, 1911–21; V.-Pres., 1914; Council, 1921), *Ellesmere, Gratwicke-road, Worthing.*

1910 ‡ White, Major Edward Barton, M.R.C.S., *Herrison, Dorchester.*

1918 White, Ronald Senior, *Suduganga Estate, Matale, Ceylon.*

1923 ‡ Whitfield, F. G. S., 25, *Drayton-gardens, S. Kensington,* S.W.

1913†‡Whitley, Percival N., *Brantwood, Halifax*; and *New College, Oxford.*

1921 ‡ Whitney, W. B., B.Sc., A.M.Inst.C.E., *Glen Doone, Gerrards Cross, Bucks.*

1913 † Whittaker, Oscar, F.R.M.S., *Box* 552, *Chilliwack, British Columbia.*

1917 ‡ Wickham, Rev. Prebendary A. P., *East Brent Vicarage, Highbridge, Somerset.*

1906 Wickwar, Oswin S., *Gresham, Cambridge Place, Colombo, Ceylon.*

1903 ‡ Wiggins, Clare A., C.M.G., M.R.C.S., *The Folly, Watlington, Oxon.*

1923 Wightman, A. J. C., *Aurago, W. Chiltington Common, Pulborough, Sussex.*

1896 ‡ Wileman, A. E., *Lane End, Westcott, nr. Dorking.*

1922 ‡ Wilkinson, Capt. D. S., *Board of Agriculture, Nicosia, Cyprus.*

1923 Wilkinson, Harold, *P.O. Box* 93, *Kampala, Uganda.*

1911 ‡ Williams, C. B., M.A., *Ministry of Agriculture, Cairo, Egypt,* and 20, *Slatey-road, Birkenhead.*

1915 Williams, Harold Beck, *Briar Cottage, Vale-road, Claygate, Surrey.*

1921 ‡ Willmer, E. Nevill, *Trafford Hall, near Chester.*

1922 Wilson, F. E., "*Jacana,*" *Darling-road, E. Malvern, Melbourne Australia.*

1921 ‡ Wilson, H. I., O.B.E., M.A., F.Z.S., 139, *Bishop's Mansions, Fulham,* S.W. 6.

1919 † Wilson, Lt.-Col. R. S., *Army and Navy Club, Pall Mall,* S.W.

1915 Winn, Albert F., 32, *Springfield Avenue, Westmount, Montreal, Canada.*

1922 ‡ Winser, H. E., 2, *Mead-road, Cranleigh, Surrey.*

1923 ‡ Winstanley, E. J., L.D.S., R.C.S., 32, *Belsize Grove, Hampstead,* N.W. 3.

1920 ‡ Withycombe, Cyril Luckes, Ph.D., M.Sc., D.I.C., *Imperial College of Tropical Agriculture, Trinidad, B.W.I.*

1919 Wood, H. Worsley, 31, *Agate-road, Hammersmith,* W. 6.

1905 Woodbridge, Francis Charles, *Briar Close, Latchmore-avenue, Gerrards Cross S.O., Bucks.*

1914 ‡ Woodforde, Francis Cardew, B.A., c/o *University Museum, Hope Department, Oxford.*

1921 Woolett, G. F. C., *Sipilang, Province Clarke, B.N. Borneo.*

1922 Wright, A. E., *Burnleigh, Kent Bank-road, Grange-over-Sands.*

1919 Wytsman, P., *Quatre Bras, Tervueren, Belgium.*

ADDITIONS TO THE LIBRARY

During the Year 1923.

Arnold (G.). The Sphegidae of S. Africa.
Barraud (P. J.). A Revision of the Culicine Mosquitoes of India.
Bethune-Baker (G. T.). A Revision of the Genus *Tarucus*.
——— A Monograph of the Genus *Catochrysops*, Bdv.
Bondar (G.). Aleyrodidae do Brazil.
Brunetti (E.). Fauna of British India. Diptera, Vol. III.
Bugnion (E.). La Guerre des Fourmis et des Termites.
Buxton (P. A.). Animal Life in Deserts.
Eltringham (H.). Butterfly Lore.
Forel (A.). Le Monde social des Fourmies du Globe.
Froggatt (W. W.). Forest Insects of Australia.
Iraq. Survey of the Fauna of Iraq.
Kaye (W. J.). A Catalogue of the Lepidoptera Rhopalocera of Trinidad. Appendix by J. Guppy.
Lutz (F. E.). Fieldbook of Insects.
Mack (H.). Adventures among Bees.
National Trust, Report of the
Oberthür (C.). Études de Lepidopterologie Comparée.
Oudemans (Dr. A. C.). Flora en Fauna der Zuiderzee.
Packard (A. S.). Entomology for Beginners.
Pearce (Miss E. K.). Typical Flies. 2 vols.
Saunders (E.). Papers on Hymenoptera, &c., contributed to the E.M.M. 2 vols.
——— Synopsis of British Hymenoptera. 2 vols. (Author's annotated copy.)
Senior-White (R.). Catalogue of Indian Insects.
Sherborn (C. D.). Index Animalium. Section II. Pt. 1.
Vorbrodt (K.) and Müller-Rutz (J.). Die Schmetterlinge der Schweiz. 2 vols.
Wheeler (Prof. W. M.). Social Life among the Insects.

Numerous Separates by Messrs.

Adkin (R.), Barraud (P. J.), Bethune-Baker (G. T.), Buxton (P. A.), Cockerell (T. D. A.), Deville (J. S.-C.), Donisthorpe (H.), Dover (C.), Forel (A.), Frison (T. H.), Green (E. E.), Kaye (W. J.), Minnich (D. E.), Oudemans (Dr. A. C.), Peyerimhoff (P. de), Poulton (E. B.), Reitter (E.), Scott (H.), Senior-White (R.), Theobald (F. V.), Tillyard (R. J.), Tragardh (I.), Wheeler (W. M.), Williams (C. B.) and many others, presented by the authors and by the following Fellows,—R. Adkin, H. E. Andrews, P. J. Barraud, Prof. T. D. A. Cockerell, H. Donisthorpe, Prof. T. B. Fletcher, Rev. F. D. Morice, W. J. Kaye, Prof. E. B. Poulton, W. G. Sheldon, R. J. Tillyard, and others.

List of Periodicals received in the Society's Library.

BRITISH ISLES.

Annals and Magazine of Natural History.
Bulletin of Entomological Research.
Entomologist.
Entomologist's Monthly Magazine.
Entomologist's Record and Journal of Variation.
Journal of the Linnean Society of London.
Transactions of the Linnean Society of London.
Transactions of the London Natural History Society.
Proceedings of the South London Entomological and Nat. Hist. Society.
Museums Journal.
Nature.
Journal of the Queckett Microscopical Club.
Proceedings of the Royal Society.
Philosophical Transactions of the Royal Society.
Review of Applied Entomology. Series A. and B.
Journal of the Royal Microscopical Society.
Zoological Record.
Proceedings of the Zoological Society.
Naturalist.
Annual Report of the Royal Agricultural Society.
Scientific Proceedings of the Royal Dublin Society.
Vasculum.
Irish Naturalist.
Year Book of Scientific Societies.
Proceedings and Transactions of the Entomological Society of London.
Ectoparasites.
Journal of the Essex Field Club. Essex Naturalist.
Annual Report and Proceedings of the Lancashire and Cheshire Entomological Society.
Hope Reports.
Transactions of the Carlisle Natural History Society.

EUROPE.

Annali Museo Civico di Storia Naturale di Geneva.
Bollettino della Società Entomologica Italiana.
Mémoires. Société de Physique et d'Histoire Naturelle, Genève.
Compte Rendu. Société de Physique et d'Histoire Naturelle, Genève.
Annuaire. Academie Royale des Sciences et Belles Lettres de Belgique.
Bulletin. Academie Royale des Sciences et Belles Lettres de Belgique.
Memoires. Academie Royale des Sciences et Belles Lettres de Belgique.
Annales. Société Entomologique de Belgique.
Bulletin. Société Entomologique de Belgique.
Memoires. Société Entomologique de Belgique.
Verhandlungen der Zoologisch-botanischen Gesellschaft.
Iris.
Annalen Naturhistorischen Museums in Wien.
Wiener Entomologische Zeitnng.

Boletin de la Real Sociedad Española de Historia Natural.
Memoirs de la Real Sociedad Española de Historia Natural.
Anales de la Real Sociedad Española de Historia Natural.
Bulletin. Société entomologique de France.
Annales. Société entomologique de France.
L'Amateur de Papillons.
Zeitschrift. Deutsche Entomologischen Gesellschaft.
Entomologische Mitteilungen.
Zeitschrift fur wissenschaftliche Insektenbiologie.
Entomologische Rundschau.
Insekten Börse.
Societas Entomologica.
Entomologische Zeitschrift. Frankfurt.
Abhandlungen. Senckenbergischen naturforschenden Gesellschaft.
Bericht. Senckenbergischen naturforschenden Gesellschaft.
Entomologiske Meddelelser.
Tijdschrift voor Entomologie.
Entomologiska Berichten.
Études Lepidopterologiques Comparée.
Internationale Entomologische Zeitschrift.
Jahrbücher des Nassauischen Verein fur Naturkunde.
Bulletin de la Société Lepidopterologique de Genève.
Mitteilungen. Bulletin de Schweizerische entomologische Gesellschaft.
Annales. Museé Nationalis Hungarici.
Notulae Entomologica.
Norsk Entomologisk Tidsckrift.
Revue Mensuelle de la Société Entomologique Namuroise.
Bulletin. Société d'Histoire Naturelle de Toulouse.
Stettiner Entomologische Zeitschrift.
Breslauer Entomologische Zeitschrift. Breslau entomologische Verein.
Bollettino del Laboratorio di Zoologia Generale e Agraria. Portici.
Entomologisk Tidskrift.
Broteria Revista.
Redia-Giornale di Entomologie.
Knowia.
Verhandlungen. Naturforschender Verein in Brünn.

AMERICA.

Annual Report of the Smithsonian Institution.
Proceedings of the Entomological Society of Washington.
,, ,, ,, National Academy of Science, Washington.
Smithsonian Miscellaneous Collections.
Proceedings of the Academy of Sciences, Philadelphia.
Transactions of the American Entomological Society.
Entomological News.
Acta. Academia Nacional de Ciencias en Cordoba.
Boletin. Academia Nacional de Ciencias en Cordoba.
Journal of the Board of Agriculture of British Guiana.
Canadian Entomologist.
Proceedings and Transactions of the Royal Society of Canada.
Journal of the New York Entomological Society.
Proceedings of the United States National Museum.

Report of the Michigan Academy of Science.
Revista Museo Paulista.
Boletin da Sociedade Entomologica.
West Indian Bulletin.
Annual Report of the Entomological Society of Ontario.
Journal of the Boston Natural History Society.
Proceedings of the Boston Natural History Society.
Memoirs of the Boston Natural History Society.
Occasional Papers of the Boston Natural History Society.
Journal of the Brooklyn Entomological Society.
Bulletins. United States National Museum.
West Indian Agricultural News.
Proceedings and Transactions of the Nova Scotian Institute of Science.
Bulletins. United States Department of Agriculture.

AFRICA.

Memoirs of the South African Museum.
Annals of the Durban Museum.

INDIA AND THE FAR EAST.

Agricultural Journal of India.
Scientific Reports of the Agricultural Research Institute, Pusa.
Report of the Entomological Meeting at Pusa.
Journal of the Bombay Natural History Society.
Common Insects of Japan.
Trübia.
Spolia Zeylanica.

AUSTRALASIA.

Proceedings. Royal Society of S. Australia.
Transactions. Royal Society of S. Australia.
Proceedings. Linnean Society of New South Wales.
Transactions. Linnean Society of New South Wales.
Memoirs of the Queensland Museum.
Queensland Naturalist.
Proceedings. New Zealand Institute.
Transactions. New Zealand Institute.
Records of the South Australia Museum.

WORKS WHICH APPEAR BY INSTALMENTS.

Gli Insetti.
Seitz, Macrolepidoptera of the World.
Collections Zoologiques de Baron de Selys-Longchamps.
Genera Insectorum.
Lepidopterorum Catalogus.
Coleopterorum Catalogus.
Entomological Publications of the British Museum (Nat. Hist.).
Entomological Fauna of Indo-China.

Many important entomological memoirs in periodicals not devoted exclusively to entomology are also obtained.

BENEFACTIONS.

List of Donations of the amount or value of Twenty pounds and upwards.

1852.

Miss Bromfield, 67 volumes from the library of W. A. Bromfield.

1861.

H. T. Stainton, £25.*

1864.

J. W. Dunning, £123 5*s*.

1867.

The same, towards cost of publications, £105.

1868.

H. J. Fust, towards the cost of his paper on Geographical Distribution, £25.

The Royal Society, for the same, £25.

1869.

J. W. Dunning, £50.

W. W. Saunders, cost of drawing and engraving 24 plates for Pascoe's "Longicornia Malayana."

1870.

J. W. Dunning, £20.

The same, the entire stock of eight vols. of the Transactions.

1872.

The same, towards cost of publications, £50.

1875.

The same, cost of removal of Library and new book-cases, £99 17*s*. 4*d*.

1876.

The same, towards cost of publications, £150.

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H. T. Stainton, £20 10*s*. 6*d*.

* It has not always been possible to find the exact purpose for which the earlier money gifts were intended, but they appear to have been usually in support of the publications

1880.

The same, £20.

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J. W. Dunning, towards cost of publications, £40.

H. T. Stainton, for the same, £25.

1882.

The same, £30.

1883.

The same, £35.

1884.

J. W. Dunning, £50.

H. T. Stainton, £40.

W. B. Spence, his late father's library.

1885.

J. W. Dunning, £35.

The same, the whole cost of the Society's Charter.

1893.

The same, towards cost of publishing the Library Catalogue, £25.

1894.

The same, £45.

The Misses Swan, £250 for the "Westwood Bequest," the interest to be used for plates in the Transactions.

F. D. Godman (in this and subsequent years), "Biologia Centrali-Americana."

1898.

Mrs. Stainton, about 800 volumes and pamphlets from H. T. Stainton's Library.

1899.

S. Stevens, legacy, £100.

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G. W. Palmer, M.P., towards cost of printing G. A. K. Marshall's paper on the Bionomics of African Insects, £30.

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1903.

H. J. Elwes, cost of plates to illustrate his paper on the Butterflies of Chile, £36 18*s.* 2*d.*

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1904.

H. L. L. FELTHAM, towards cost of plates for R. Trimen's paper on S. African Lepidoptera, £20.

1906.

The same, towards cost of plates for R. Trimen's paper on African Lepidoptera, £20.

1908.

E.A. ELLIOTT (in this and subsequent years), Wytsman's "Genera Insectorum."

1909.

Ch. OBERTHÜR (in this and subsequent years), his "Lépidopterologie comparée."

1910.

Dr. T. A. CHAPMAN, towards cost of plates for his papers on Life-histories of Lepidoptera, £25.

1911.

Sir G. KENRICK, Bart., cost of plates for his paper on Butterflies of Dutch New Guinea, £54.

1912.

Dr. T. A. CHAPMAN, cost of plates for his papers on Life-histories of Lepidoptera, £35 6*s*. 5*d*.

1913.

The ROYAL SOCIETY, towards the publication of D. Sharp's paper on the Genitalia of Coleoptera, £60.

1914.

F. D. GODMAN, cost of plates for G. C. Champion's papers on Mexican and Central American Coleoptera, £22 7*s*. 6*d*.

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E. E. GREEN, large binocular microscope.

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1920.

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The Rt. Hon. Lord Rothschild, £105.

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W. G. F. Nelson, £63, reduction of solicitor's charges.

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R. Adkin, £40, cancellation of debentures drawn.

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K. J. Morton, £20.

J. J. Joicey, Lantern and Stand for the Meeting Room.

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The Rt. Hon. Lord Rothschild, £22 15*s*. 4*d*., cost of plates in the Proceedings for 1920.

Jesus College, Oxford, through Prof. E. B. Poulton, F.R.S., £100.

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E. E. GREEN, £25 (making £50 in all).

W. H. B. FLETCHER, £25.

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E. W. ADAIR, £20.

The Misses CHAPMAN, two bookcases.

1923.

Donations in aid of the purchase of 41 Queen's Gate—

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A. C. F. MORGAN, £20.

H. J. TURNER, £20.

H. H. C. DRUCE, £250 (part of bequest of £1000) for new books.

TRANSACTIONS

OF THE

ENTOMOLOGICAL SOCIETY

OF

LONDON

FOR THE YEAR 1923.

I. *On the Types of* Carabidae *described by Schmidt-Goebel in his Faunula Coleopterorum Birmaniae.* By H. E. ANDREWES.

[Read October 18th, 1922.]

THE subject of this memoir is a series of exactly one hundred species of Carabidae, nearly all new at that time, described by Dr. H. M. Schmidt-Goebel in the year 1846. This collection, along with much other interesting material, has been sent to me for examination by Dr. Jan Obenberger on behalf of the Directors of the Prague Museum, and I desire to offer him and them my warm thanks for their courtesy and assistance. During the seventy-seven years which have elapsed since the Faunula was published there have been numerous references in entomological literature to the species described, but subsequent identifications, generally founded on the descriptions, have frequently been erroneous, and to many species there has been no reference at all. So far as is revealed by the literature of the subject, Chaudoir is the only author who personally examined the collection, and his observations do not throw a great deal of light upon it.

In 1889, and at greater length in 1892, Bates published in the Annals of the Genoa Museum an account of the large collection of Carabidae formed by Mr. Leonardo Fea in Burma: a considerable number of the species were identified with those described by Schmidt-Goebel, and Dr.

Gestro, to whom I am much indebted for his kind help both on this and other occasions, sent at my request from the Genoa Museum the whole of these specimens for examination and comparison with the typical examples.

The collection was formed during the years 1836–40 by Dr. J. W. Helfer, a physician of Czech nationality, who seems to have spent a considerable time in the East. He collected first at Bushire in Persia, then for a few months in the neighbourhood of Calcutta, and subsequently for a much longer period in Tenasserim. Here he made Mergui his headquarters and thence made numerous excursions in all directions: these were partly exploring expeditions on behalf of the Indian Government for coal and other minerals, but largely also with a view to collecting insects. Early in 1840 he went to the Andaman Islands and was there killed by the islanders. The whole of his collections were sent home to Prague, the last section being brought by his widow, who made some further additions to it both at Mergui and at Darjiling. Helfer seems to have done his best to keep distinct the insects taken in the different localities, but was not entirely successful. Schmidt-Goebel was doubtful regarding the locality of many of the species he described, Chaudoir expressed similar doubts, and, although I think the localities given are in the main correct, we cannot feel quite sure about them, and some are almost certainly erroneous.

It was the author's intention to describe the insects of the Helfer collection in a series of ten or twelve papers with numerous illustrations, but only one number appeared, with three plates; this deals with the Carabid group Truncatipennes, and breaks off in the middle of a description at the commencement of a section on the Scaritini. Dr. Obenberger informs me that Dr. Schmidt-Goebel was a Pole, who practised as a physician in Prague. At about the time when the Faunula was being written, it seems that he was obliged to move rather suddenly to Krakow, and presumably it was owing to this that the work was discontinued. As, however, he lived for many years afterwards and only died on Aug. 7, 1882, the explanation is not altogether satisfactory.

Considering the period when he lived I consider Schmidt-Goebel's work first-rate. His descriptions in the main are detailed and accurate, so that I make no attempt in the following pages to redescribe the species he dealt with,

but merely add notes on such points as he omitted, with a few comments which I hope may be of use in identifying the various species, some indication of their geographical distribution, and all the references I can find made by subsequent authors. In quoting my two papers on old types of Carabidae published in these Transactions in 1919 and 1921, I have only cited in a parenthesis those dates and the page referred to. I have numbered the species and go through them *seriatim,* following the order in the Faunula.

1. **Casnonia bimaculata** (p. 18). Chaud., Bull. Mosc. 1848, i, 47; *id.* Bull. Mosc. 1850, i, 26; *id.* Bull. Mosc. 1872, ii, 407; Bates, Ann. Mus. Civ. Gen. 1892, 381; Andr., Ann. Mag. Nat. Hist. (9), iii, 1919, 479.

Schmidt-Goebel mentions two specimens from the Burmese Provinces, but there are actually three examples in the collection. In 1848 Chaudoir proposed for the species the new name *C. distigma* (*C. bimaculata* having been used by Redtenbacher in 1844), and in 1919 I proposed for the genus the new name *Arame* (*Casnonia* being a synonym of *Ophionea*).

Bates records the species from Katha in Upper Burma; I have seen this example and another specimen from Bhamo, both taken by Mr. L. Fea, and agreeing perfectly with the typical specimens. He also mentions a specimen from S.E. Borneo (*Doherty*). I have seen one other example, labelled "Pagat, Borneo (*Grabowsky*)," which was presented to me by Mr. T. G. Sloane.

It is curious that Schmidt-Goebel, usually so accurate an observer, should have missed the setiferous pores on the elytra, such an important character in this genus, but they are small and in the typical specimens the setae are nearly all abraded. In my example, which agrees in other respects with those from Burma, the setae are long, upright, and very conspicuous. There are seven on interval 3, of which five are rather close together on the front half, and two, more widely separated, nearer the apex; intervals 5 and 7 have each one, on 5 at about a fourth from base, and on 7 at about a fourth from apex. In the Fea examples some of the setae have gone, but most of the pores are visible.

2. **Casnonia tetraspilota** (p. 19). Chaud., Bull. Mosc. 1848, i, 49; *id.* Bull. Mosc. 1872, ii, 406; Andr., Ann. Mag. Nat. Hist. (9), iii, 1919, 479.

There are two specimens labelled Tenasserim. As in the preceding species the elytral setae are abraded, but there are four pores clearly visible on interval 3, of which the two hind ones are rather close together. There are no pores on intervals 5 or 7. An example from the Indian Museum is labelled "Assam, Garo Hills, Tura (*S. W. Kemp*)," and was taken at light; a second one is labelled "East side of Dawna Hills, 2100 feet (*F. H. Gravely*)." There is also an example in the British Museum labelled "Andaman Is. (*Roepstorff*)"; this has no head, and the elytral spots are yellower and more elongate than in the type form.

3. **Ophionea cyanocephala** F. (p. 20) (1921, 161). I need not repeat my previous notes on this species, but I may add that on interval 3 there are four setiferous pores, two on the front half, and the other two close together near the apex. The single example in the collection is labelled "Bengal."

4. **Ophionea interstitialis** (p. 20). Gestro, Ann. Mus. Civ. Gen. 1875, 855; Bates, Ann. Mag. Nat. Hist. (5), xvii, 1886, 199; *id.* Ann. Soc. Ent. Fr. 1889, 279; *id.* Ann. Mus. Civ. Gen. 1892, 380; Bouch., Ann. Soc. Ent. Fr. 1903, 172; Maindr., Bull. Soc. Ent. Fr. 1910, 35.

There are two specimens. The author refers to the numerous setiferous pores on interval 3; in both typical specimens and in most of the examples I have examined there is also one near the base on interval 5. The species is widely distributed through S.E. Asia, including the Malay Archipelago.

5. **Ophionea nigrofasciata** (p. 21). Bates, Ann. Mus. Civ. Gen. 1892, 380; Bouch., Ann. Soc. Ent. Fr. 1903, 172; Maindr., Bull Soc. Ent. Fr. 1910, 35.

Three typical specimens. On interval 3 in this species there are five setiferous pores, two on the front half, and three close together near the apex.

This well-known species is found in N. E. India, Burma, Indo-China, and the Malay region. In Plate 3 of the Atlas to Lacordaire's Genera Coleopterorum there is a figure (No. 2), alleged to be *O. cyanocephala* F., but actually representing this species.

6. **Odacantha litura** (p. 22). Chaud., Bull Mosc. 1872, ii, 404; *id.* Bull. Mosc. 1877, ii, 266; Bates, Trans. Ent. Soc. Lond. 1883, 278; Bouch., Ann. Soc. Ent. Fr. 1903, 173; Andr., Ann. Mag. Nat. Hist. (9), iii, 1919, 479.

The two typical specimens belong to different species, both coming under the genus *Arame;* I designate these (1) and (2). The coloration is similar, but the author's description of the apical testaceous marking does not convey a very accurate impression. In each case interval 3 has three setiferous pores.

(1) Head almost circular in outline, the eyes very flat, with rounded genae, the upper surface coarsely punctate, sides, clypeus, and labrum smooth, but clypeus with a few small punctures at base. Prothorax as long as head, much dilated in middle and constricted before base, densely and coarsely punctate. Elytra deeply striate, the striae coarsely punctured on basal half, where the intervals are very convex, intervals 7–8 hardly raised near apex, testaceous apical border covering about a fifth of elytra, rather dark, but lighter on intervals 2–4. This specimen agrees with the description rather better than (2), and I propose to retain for it the name of *litura.* I have in my collection another Burmese example, taken at Tharrawaddy by the late Mr. G. Q. Corbett. I have compared with the type Bate's two specimens, taken by Mr. George Lewis on Virgin's Peak, Nagasaki, and they agree with it very well.

(2) Head elongate, triangular, eyes moderately flat, front rather sparsely punctate, clypeus quite smooth, the upper surface behind level of eyes smooth and polished. Prothorax elongate, not much dilated in middle or much constricted at base, surface as coarsely punctate as in (1), though rather less closely. Elytra a little more elongate than in (1), the striae less deep and intervals therefore less convex, though not flat, intervals 7–8 raised on each side in the form of a small boss near apex, testaceous apical border covering about a fourth of elytra, a little lighter on intervals 3–4 and 7–8. I have compared this specimen with the type of *Arame* (*Casnonia*) *graciliceps* Bates (Ann. Mus. Civ. Gen. 1892, 381), which came from Bhamo, and with a second example from Teinzo. I find it to agree very well with these, especially with the latter, in which the eyes are a little more prominent and the prothorax a little wider. Other localities are :—Burma, Tharrawaddy and Taung-ngu (*G. Q. Corbett*); Bengal, Calcutta "at light" (*F. H. Gravely*), and on the Eastern Bengal Railway (*S. W. Kemp*); Cambodia, Kompong Kedey (*R. Vitalis de Salvaza*).

This appears to be the specimen figured in the unsuccessful Plate I, No. 9—at all events it represents it better than it does the specimen I have designated *litura*. On the assumption that this view is correct, I may point out that in the figure the eyes are too prominent, the prothorax too much narrowed in front, the surface with too few and too small punctures, the elytra a little too short and with the striae too shallow, the apical marking too light, too uniform, and too clearly defined in front.

7. **Drypta obscura** (p. 23).

Chaudoir (Bull. Mosc. 1861, ii, 551) referred vaguely to this and the two following species, but without attempting any identification: so far as I know, this is the only reference.

I find that this species, of which there are three typical examples in the collection, is very closely allied to *D. crassiuscula* Chaud. from N. India. The type of Chaudoir's species measures 10·5 mm., but an example which I compared with it is 12·5 mm. long. Schmidt-Goebel's species is a little smaller, viz. 10·0 mm. Though very dark, it is bluer in colour, the apex of the femora is black over a greater length, the tibiae are black (testaceous in *crassiuscula*), and the tarsi brown. The puncturation throughout is rather finer, there is a larger smooth area on middle of front, the prothorax is rather wider, the sides more rounded in front, the front angles less conspicuous, and the border minutely but more sharply tuberculate.

D. crassiuscula Bates (Ann. Mus. Civ. Gen. 1892, 383) from Shwegu is rather larger, the apex of the femora (narrowly) and the whole of the tibiae black; the elytral intervals are rather flat and the surface more densely punctate. The border of the prothorax is more clearly tuberculate even than in *obscura*, and much more than in *crassiuscula* Chaud.

Bates says of his *D. siderea* (Ann. Mus. Civ. Gen. 1892, 382) that its only near ally is the Bornean *D. mandibularis* Cast. To my eyes it is a very near neighbour of the species considered above, differing chiefly in the wholly blue-black colour of the legs and the rougher sculpturing of the elytra, the intervals being rather more convex, smoother along median line, the punctures in the striae more evidently transverse. It seems to me quite possible that some of these species may have to be united, when more material is available for study.

8. **Drypta lugens** (p. 23).

A single example, 9·0 mm. in length, strikingly like the preceding species in form, but with narrower head and prothorax, and much less inflated genae. The general coloration is darker, with only a suggestion of blue, joint 3 of the antennae black, tibiae and tarsi testaceous. Head very coarsely and confluently punctate, much more so than in *obscura*, without any smooth area on front. Prothorax relatively narrow (much more so than in *obscura* and rather more so than in *crassiuscula*), coarsely and confluently punctate, border minutely crenulate (as in *crassiuscula*). Elytra much more finely and closely punctate than in the other two species, and therefore duller in appearance, a little less closely on interval 3.

I have seen no other example of this species.

9. **Drypta tristis** (p. 23).

Another single example, nearly 10·0 mm. in length. I have seen no other example, and I know of no near ally. As Schmidt-Goebel has given a fairly adequate description, I need not describe the species again, but I think it may be useful if I compare it with another well-known Indian species, such as *D. flavipes* Wied.

Black, but with a very distinct brassy reflection (not mentioned in the description) on the disk of the elytra. Head about the same size, the eyes rather less prominent, the neck strongly constricted behind the eyes, the puncturation similar. Prothorax rather flat above (not cylindrical as in *flavipes*), with a well-marked but not crenulate border, much wider in front, with rounded sides, contracted at three-fourths from apex, the hind angles projecting a little outwards; median line more strongly marked, and basal foveae distinct, surface quite as closely and rather more finely punctate. Elytra about the same length, but a good deal wider, a little less convex, the outer angle of the apical truncature completely rounded, striae wider, deeper, and rather more coarsely punctate, the intervals more convex, surface much more finely but not more closely punctate; the legs thicker, the femora in particular being more stoutly built.

10. **Dendrocellus discolor** (p. 24) = *Desera nepalensis* Hope (Zool. Misc. 1831, 21) (1919, 170). A single example. My surmise as to the identity of these two species turns out to be correct, and for further details I need only refer to the note under *D. nepalensis* in my former paper.

11. **Dendrocellus flavipes** (p. 24) (1919, 170).

Schmidt-Goebel identified his species doubtfully (and erroneously) with *Drypta flavipes* Wied. (Zool. Mag. ii, 1, 1823, 60). In *Drypta* the claws are simple, in *Desera* (= *Dendrocellus*) they are pectinate; and Chaudoir proposed the new name of *rugicollis* for Schmidt-Goebel's species.

There are two examples, both from Calcutta, and I regard them as slight colour variations of the next species, *D. geniculatus* Klug. In the latter species the apex of joint 1 of the antennae and of the femora is dark, but at the end of the description of *flavipes* we read "Zuweilen die Schenkelspitzen (auch die des ersten Fühlergliedes) etwas dunkler." Apart from the flavous antennae and femora, I can see nothing to distinguish the two species; the prothorax is a little more coarsely and less closely punctate than is usual in *D. geniculatus*, but the further slight differences indicated by the author are, I think, illusory.

Following the description is a long discourse on *D. flavipes* Wied., *D. coelestina* Klug, etc. I have already referred to these species in former papers (1919, 167–8, 1921, 173).

12. **Dendrocellus geniculatus** Klug, Jahrb. Ins. 1834, 52 (p. 25).

Three examples from Calcutta, which (although I have not seen Klug's type) I think are correctly identified. The species is a common one and has been referred to by numerous authors; it is widely distributed throughout S.E. Asia, including Japan and the Malay Archipelago.

13. **Galerita orientalis** (p. 26). Bates, Ann. Mus. Civ. Gen. 1889, 109, and 1892, 385.

Two examples ♂♀, the former very light in colour and undeveloped. Examples taken by Mr. L. Fea in some numbers, and in various Burmese localities, were identified by Bates with *orientalis*. Bates has confused two species; there are two of the Fea examples in my collection and one in the British Museum, which I have compared with Schmidt-Goebel's type: one of these, from Bhamo, agrees exactly, but the other two, from Karin Cheba and Teinzo, are different, and for these I propose the name of *G. batesi*. All the three examples in the Genoa Museum, which Dr. Gestro has kindly sent me for examination, belong to this latter species; they come from Karin Cheba (♂), Palon in Pegu (♂), and Thagata in Tenasserim (♀).

think it will be sufficient if I draw attention to the salient differences between the two species. I have compared two ♀♀.

G. orientalis. Apical third of joint 1 of antennae fuscous. Head with frontal foveae small but deep, and median ridge consequently well-marked, vertex and genae comparatively smooth, with few and shallow punctures, eyes rather prominent. Prothorax with hind angles rectangular, but gently rounded, surface with fine and close, but superficial puncturation, transversely confluent. Elytra with costae not much raised, the two very fine secondary raised lines between them much closer to each other than to the costae, the interval between each of them and the adjoining costa finely and rather irregularly aciculate-punctate (but there is a single row of punctures on each side of costae 1 and 7, and here and there elsewhere). An example (♂) in the British Museum from the Patkai Mountains in Assam belongs, I think, to Schmidt-Goebel's species, but the puncturation on the elytra is more regular than in the type.

G. batesi. Apical two-thirds of joint 1 of antennae fuscous. Head with frontal foveae rather wide and shallow, the interval between them only gently raised, the whole area behind mid-eye level coarsely punctate, eyes not prominent. Prothorax with hind angles projecting a little outwards, surface closely and confluently punctate, the punctures a little smaller than those on the head, but much coarser and deeper than in *orientalis*. Elytra with costae well-marked, the interval between the secondary lines hardly less than that between each of them and the adjoining costa, this latter interval with a single row of fine aciculate punctures. The type (Karin Cheba ♀) is in my collection. The example in the British Museum (Teinzo ♂) differs only in having the prothorax rather more finely punctate, less contracted behind, the angles right, not projecting laterally. All the three examples in the Genoa Museum have joint 1 of the antennae almost entirely black.

14. **Zophium olens** Rossi, Faun. Etrusc. 1, 1790, 217, t. 5, f. 2 (p. 28).

The three examples of this well-known species, whose range extends from the South of France to Indo-China, agree entirely with the traditional form, though I do not know Rossi's type.

Schmidt-Goebel writes Zophium, Latreille—the author of the genus—Zuphium, and Mr. Bedel prefers Zoyphium. I must leave to Greek scholars both the question of derivation and that of spelling.

15. **Zophium bimaculatum** (p. 28). Gestro, Ann. Mus. Civ. Gen. 1875, 864; Bates, Ann. Mus. Civ. Gen. 1892, 386.

Two examples. I have seen others from Tharrawaddy (*G. Q. Corbett*) and Palon (*L. Fea*). Dr. Gestro records it from Bangkok (*Castelnau*), and there is a specimen from Cambodia in the Brussels Museum. The species is probably widely distributed in public collections.

16. **Zophium vittigerum** (p. 28). Chaud., Rev. et Mag. Zool. 1872, 105.

A single example. Chaudoir tells us that, when in Prague, he examined this specimen, and formed the opinion that it was an immature example of *Z. bimaculatum*, in which I concur.

17. **Zophium modestum** (p. 29). Chaud., Bull. Mosc. 1862, iv. 312; Gestro, Ann. Mus. Civ. Gen. 1875, 864; Bates, Ann. Mus. Civ. Gen. 1892, 387.

Three examples. Another species which seems to be well known. Chaudoir records it from North India, and other localities are:—Nagpur (*E. A. D'Abreu*), Calcutta (*F. H. Gravely*), Satara in Bombay (*F. H. Gravely*), Tharrawaddy (*G. Q. Corbett*) and Palon (*L. Fea*), Bangkok (*Castelnau*), Penang, Saigon (*coll. Fleutiaux*), and Kompong Kedey in Cambodia (*R. Vitalis de Salvaza*).

18. **Zophium piceum** (p. 29). Bates, Ann. Mus. Civ. Gen. 1892, 387.

The type is unique. This species is a very distinct one and seems to be confined to Burma, where it has been taken at Taung-Ngu (*G. Q. Corbett*) and Palon (*L. Fea*).

19. **Zophium inconspicuum** (p. 30). Bates, Ann. Mus. Civ. Gen. 1892, 387.

Another single specimen in rather poor condition. Schmidt-Goebel's excellent description, as supplemented by Bates, leaves nothing for me to add. The unusual form of the antennae and elytra led Schmidt-Goebel to think that a new genus might be necessary, but I hardly think so. Other specimens have been taken by Mr. Fea at Bhamo and Palon; but this species is not confined to Burma, for in the year 1886 I took a single specimen at Parle, in the Western Ghats, Belgaum district, Bombay.

20. **Agastus lineatus** (p. 31). Gestro, Ann. Mus. Civ.

ɔn. 1875, 867; Bates, Ann. Soc. Ent. Fr. 1889, 280; . Ann. Mus. Civ. Gen. 1892, 388.

The unique type is a wreck, but, though much darker roughout, it agrees fairly well with examples taken by r. L. Fea at Palon, two of which are in the Genoa Museum, ıd one in my collection. The specimen taken by him at ıung-Ngu, which happens to be the one bearing Bates' bel, belongs to an undescribed species. I have also seen camples from the Philippine Is. (*Semper*), Calcutta (*F. H. ravely*), and Kompong Kedey in Cambodia (*R. Vitalis ; Salvaza*). Bates reports the species from Mytho in ochin-China (*de la Perraudière*) and Dr. Gestro from angkok (*Castelnau*).

21. **Cymindis indica** (p. 31). Chaud., Genres aberrants u groupe des Cymindides, Bull. Mosc. 1875, iii, 16; Bates, ınn. Mus. Civ. Gen. 1892, 417.

Chaudoir redescribed the species four years later under he name of *Cymindis Guerini* (Bull. Musc. 1850, i, 49), ut when he came to write the memoir quoted above he ecognised the identity of his species with Schmidt-Goebel's, vhich he put under the genus *Cymindoidea* Cast. (Ann. Soc. Ent. Fr. i, 1832, 390).

Described apparently from a single example, but the ıuthor did not know whether it came from India or Burma; I find that it bears the label "Indien; Helfer."

Chaudoir's examples came from the Nilgiri Hills. The two specimens recorded by Bates were taken by Mr. L. Fea at Bhamo and Shwegoo; I have seen both of these, which are now in the Genoa Museum, and find them to agree perfectly with the type, except for the rather larger size of the curiously shaped orange spots on the elytra.

I am able to record some further localities:—Bihar, Pusa and Purneah; Orissa, Puri (*S. W. Kemp*) and Khandagiri (*F. H. Gravely*); Bombay, Kanara (*T. R. D. Bell*); Madras; Pondichery (*Perrotet*).

22. **Calleida splendidula** F. (p. 32) (1919, 164, and 1921, 161).

Four specimens from Martaban, all agreeing fairly well with an example already compared with the Fabrician type. There is no occasion to repeat here the long list of references to this well-known and widely-distributed species which I gave in my former paper in 1919.

23. **Calleida chloroptera** Dej., Spec. Gen. v, 1831, 340

(p. ·33). Chaud., Monographie des Callidides, Ann. Soc. Ent. Belg. xv, 1872, 112.

Four examples from Tenasserim, which agree fairly well with the description, and also with an example in my collection from Hong-Kong labelled as *C. chloroptera* by Chaudoir. This author thought that *C. lepida* Redt. (Reis. Novar. ii, 1867, Col. 6) from China and Japan might prove to be only a colour variety. I have not seen either Dejean's or Redtenbacher's type, but I have examined a number of specimens, which I refer to *chloroptera*, but which, as in the case of *C. splendidula* F., vary a good deal both in colour and in the form of the prothorax; judging by these, I incline to think that Chaudoir's idea is right, and that we have to do here again with a widespread and variable species.

Apart from Chinese and Japanese examples, there are others from "India" in the British Museum, and a single example from Chapra in Bengal (*Mackenzie*) in the Pusa Collection, while Mr. R. Vitalis de Salvaza has lately taken the species in Laos.

24. **Peliocypas suturalis** (p. 34).

No other author has referred to this species. There are five examples in the collection all labelled "Tenasserim," and I have a sixth in my collection labelled "Burma" only. These agree fairly closely, except in the width of the elytral fascia. The description is rather incomplete, and I therefore add a few notes. Head smooth, with two deep punctiform impressions at each side of front, and two smaller ones close to eyes, from which arise the front supra-orbital setae, labrum emarginate; base of prothorax truncate, its sides oblique, the hind angles projecting far out laterally, the sides very gently rounded in front, the front marginal seta not at the angle but at about a fifth from it; elytra at least two and a half times as wide as the prothorax, the two pores on interval 3 large and deep, at about a fourth from base and a sixth from apex respectively, sutural stripe covering intervals 1–2, widening at base and including 3, but not quite reaching apex, widening also at apical third so as to form a transverse band, rounded externally and vaguely defined, covering intervals 1–5 and occasionally also 6–7.

25. **Peliocypas signifer** (p. 35).

Like the last this species has not been the subject of any subsequent comment. There are three examples from

enasserim; I have found a fourth, labelled "Java," ı the collection of the British Museum, and there is yet nother in Mr. E. Fleutiaux' collection from Thudau-ıot in Cochin China. Very similar in size and form to he preceding species, but rather narrower. Head with ıuch shallower impressions, hind angles of prothorax ot projecting so far laterally, sides of base very distinctly marginate near hind angles, elytra a little narrower, but therwise similar in form, the hind puncture on interval 3 ery near apex. The elytral pattern tends to become ague, and this is specially the case in the specimen from Java. The sutural stripe, covering intervals 1–2, some-imes widens round the scutellum, but does not reach uite to apex; the side stripes are very vague, but seem o extend to apex, covering intervals 7–8 at base, and unning obliquely to the apex of 5–6; the transverse fascia, oining the three stripes, is at about two-fifths from apex.

26. **Peliocypas hamatus** (p. 35).

Once again there has been no comment. The collection ontains three examples from Tenasserim, and the descrip-ıon of them is not quite up to the author's usual standard. his species is a little larger, longer, and flatter than the wo previous ones, but not dissimilar in form. The frontal npressions are rather larger, but fairly deep, the sides f the prothorax a little more rounded in front, the hind ngles not quite so prominent as in *P. suturalis*, the sides f the base oblique, but only slightly emarginate; elytra ıarrower and more parallel than in the other species, triae not so deep, the hind pore on interval 3 near apex. The dark suture hardly reaches either base or apex, adjoin-ng it interval 2 is dark from about a half to three-quarters, hus forming a small elongate patch, opposite the middle of which intervals 3–4 are also infuscate over quite a small area.

I have seen no other examples of this species either from Burma or the Malay region, but I identify with it a series of specimens taken by Mr. H. L. Andrewes at 5000 feet, n the Nilgiri Hills. Some of these agree closely with the typical examples, in others the dark pattern has become light brown, and in yet others it has practically disappeared.

27. **Peliocypas luridus** (p. 35). Bates, Ann. Mus. Civ. Gen. 1892, 421.

A single example, which the author thought probably came from Burma, and which is actually labelled "Tenas-serim." Bates' identification, cited above, is perfectly

correct: I have seen two examples from Bhamo (*L. Fea*), now in the Genoa Museum, which agree perfectly with the type. This species seems to have a fairly wide range: there is a specimen from the Nevinson collection in the British Museum labelled "India," and another in the Pusa collection from Nongpoh in the Khasi Hills. I have also seen examples from Kurseong, from Gopaldhara in Sikkim, 3500 feet (*H. Stevens*), and from Haiphing in Tonkin (*U. Laboissière*).

This is a very different looking insect from the three previous species. The colour is a rather dirty testaceous, the head and prothorax tinged with red; at the apical third of the elytra is a slight V-shaped fascia, which is often faint and sometimes disappears, behind which the colour of the elytra is distinctly more pallid. The striae and the deeply impressed pores on interval 3 are fuscous and stand out very clearly against the lighter background. The upper surface, though shiny, is finely punctate and pubescent—a point missed in the description: Bates thought that the unique type might have been abraded, but this is not the case.

Schmidt-Goebel gives $2\frac{1}{2}$ lines as the length, but the specimens before me measure fully 6·0 mm. The form is long and slender. Head with shallow impressions, genae elongate and sloping very gently to the neck-constriction; prothorax barely longer than wide, sides of base oblique but not emarginate, sides gently rounded in front and sinuate behind, the front seta at a third from apex, hind angles projecting only a little laterally, median line forming slight foveae near base and apex; elytra very long and narrow, less than two and a half times as wide as prothorax, but nearly four times as long, the striae very clearly incised and punctate.

Owing to a mistake of the author, the genus *Peliocypas* has never yet been correctly identified. Bates refers to it on various occasions (Ann. Mag. Nat. Hist. (5), xvii, 1886, 207; Ann. Soc. Ent. Fr. 1889, 284; Ann. Mus. Civ. Gen. 1892, 421), but it hardly seems necessary to quote his remarks here; he thought that some of the species which he described from Ceylon under the genus *Tetragonica* might prove to be identical with Schmidt-Goebel's, but, having seen all his types, as also the types of the two species he described from Indo-China under the genus *Demetrias*, I am able to say that all of them are distinct.

Schmidt-Goebel's error was in stating that in his genus the labial palpi were truncate, whereas in fact they are acuminate (the extreme point sometimes truncate). Bates evidently thought that, apart from this, there was very little to distinguish the three genera *Demetrias*, *Peliocypas*, and *Tetragonica*. I quite share this view and propose to treat them as belonging to one genus, which, for reasons which I have given elsewhere (Trans. Ent. Soc. Lond. 1919, 91), should bear the name of *Risophilus* Leach.

Fairmaire has described one other species under the genus *Peliocypas*, viz. *P. uniformis* (Ann. Soc. Ent. Fr. 1888, 334); this came from Tonkin (*de Beauchêne*). I have not seen the type, and the description is not sufficiently detailed to enable me to say whether or not it is identical with or distinct from the Burmese species.

28. **Lionychus marginellus** (p. 37, Tab. III, fig. 3).

The figure is fairly good, but the prothorax is rather too narrow, and the colour of the antennae and legs is incorrect: the outline drawings of the buccal organs are also inaccurate, as mentioned in the text. The type is unique, and I have seen only two other examples, which came from China (probably Hong-Kong); one of these is in the British Museum, the other in my collection.

Mr. Bedel in his admirable "Catalogue raisonné des Coléoptères du Nord de l'Afrique" (1913, p. 293) says in a note to the genus *Lionychus* Wissmann: "Le genre *Lionychus* Schmidt-Goebel, 1846, est tout différent," but he gives no reason in support of this statement, nor do I know any ground for it. He also gives 1842 as the date of Wissman's description, but I cannot find anything before January 1846, when he indicated rather than described the genus (Stett. Ent. Zeit. vii, 25). Schmidt-Goebel described it in the following December on p. 389 of the same volume, but had in the meantime (June) published the further description in Faun. Col. Birm.

29. **Lionychus aeneipennis** (p. 37). Chaud., Bull. Mosc. 1850, i, 67; Motch., Études Ent. 1855, 50 (note 1); Fairm., Ann. Soc. Ent. Fr. 1888, 335.

Two examples from Martaban, which do not belong to the genus *Lionychus*. Chaudoir evidently saw that the species was an *Apristus*, closely allied to his *A. aeneomicans* from North India. Motchulsky closes a long discussion on the genera allied to *Dromius* with the remark, "Du reste l'aspect général de tous ces genres est tellement distinctif,

qu' avec un peu de routine on ne se méprendra pas en y intercallant les espèces," but this "distinctive aspect" did not deter him in the previous sentence from erroneously attributing Schmidt-Goebel's *aeneipennis* to the genus *Blechrus*. Fairmaire records the species from Tonkin, whether correctly or not I do not know, but puts it rightly under *Apristus*.

I have in my collection a specimen already compared with the type of *A. aeneomicans* Chaud., and I indicate below the slight differences I note between the two species.

A. aeneipennis. Joints 1–2 of antennae dark testaceous, palpi, femora, and tibiae dark reddish; elytra aeneous-brown. Upper surface finely shagreened, dull. Head without striation near eyes; prothorax moderately contracted behind, the sides sinuate near hind angles, surface smooth, except along base, median line well-marked but not deep (though rather deeper at extremities); elytra with rather fine striae and flat intervals, 3 with three well-marked pores, the hind one certainly setiferous.

A. aeneomicans. Antennae, palpi, and legs black; elytra aeneous. Upper surface finely shagreened, but moderately shiny. Head striate near eyes; prothorax a little wider, more contracted behind, the sides sinuate at a little distance from hind angles, surface finely and irregularly striate, punctate-striate along front margin, median line deep and wide; striae of elytra impressed, intervals moderately convex, 3 (apparently) with three pores, the two front ones almost obsolete, the hind one more distinct and setiferous.

I have seen only one other example of *aeneipennis*, which agrees well with the type, taken by my nephew, Mr. H. L. Andrewes, at Teppukadu in the Nilgiri Hills.

30. **Metabletus obscuroguttatus** Dufts., Faun. Austr. ii, 1812, 249 (p. 38).

A well-known European species, subsequently described by Dejean under the name of *Dromius spilotus* (Spec. Gen. i, 1825, 246).

This reference is quite a puzzle. There are three examples, of which the two first are labelled "Böhmen" and "Bohemia" respectively: these appear to me to belong to Duftschmid's species. The third is labelled "Dekan?" and is in such poor condition that I am unable to express any opinion about it. It was evidently this specimen which Schmidt-Goebel identified with *obscuroguttatus*.

Regarding its origin he thought Bushire in Persia and Darjiling both possible localities, but the "Dekan" more probable. As Helfer did not collect anywhere near the Deccan, it seems possible that, like Chaudoir in later years, he confused the Deccan and Dacca. Until undoubted specimens of *obscuroguttatus* are forthcoming from the Indian region, the occurrence of the species in that part of the world must remain doubtful.

31. **Metabletus quadripunctatus** (p. 39). Bates, Trans. Ent. Soc. Lond. 1883, 284; *id.* Ann. Mus. Civ. Gen. 1892, 418.

Bates identified rather doubtfully with this species an example taken by Mr. George Lewis at Yuyama in Japan; it was an aberrant form, with two punctures on the left elytron and four on the right. I have seen this specimen, now in the British Museum, as also two other examples from the same locality, and they seem to me to belong to this species. He subsequently identified with it other examples taken by Mr. L. Fea in Burma at Taung-Ngu, Karin Ghecu, Thagata and Mt. Muleyit. I have seen four of these specimens and find them to agree perfectly with the typical specimens. I have also in my collection examples from Prome in Burma (*G. Q. Corbett*), the Nilgiri Hills, Ouchterlony Valley, 3500 feet (*H. L. Andrewes*), and Doesonlanden in Borneo (*Wahnes*). In the British Museum there are examples from Ceylon (*Dr. Thwaites*), the Ruby Mines in Upper Burma and Tavoy in Tenasserim (*Doherty*), and from S. E. Borneo.

There are four examples in the collection indicated as "types" and two others not so marked. These are all labelled "Calcutta," and according to the text were taken at the adjoining locality of "Cossipoor."

The description is excellent, and only not quite accurate in regard to the pores on interval 3. Of these the front one is placed a little before the middle, the hind one at about a fourth from apex; both of them adjoin stria 3.

32. **Dromius plagiatus** (p. 39).

There are two specimens in the collection, a fairly good one labelled "Oestreich, Hofmann" and a second one in poor condition labelled "Calcutta, Helfer." Schmidt-Goebel tells us that this latter example "bears in Helfer's list of the insects collected around Calcutta the provisional name *Dr. persicus*, and agrees with the description quoted above. There are, however, no examples from Persia, but only one from Cossipoor near Calcutta."

The descriptions quoted are those of the palaearctic species *Microlestes plagiatus* Duftschmid and Sturm, and *Microlestes corticalis* Dufour and Dejean, treated here as identical, but now known to be distinct, though almost exactly similar in appearance. I think Helfer's specimen clearly belongs to one or other of these species, though its condition does not enable me to say which. Dr. Holdhaus, in his Monograph on the palaearctic species of *Microlestes* (Denkschr. Nat. Kl. Acad. (Wien) lxxxviii, 1912, 517) puts it under *M. corticalis*, where I am content to leave it.

Helfer made collections at Bushire in Western Persia, and went from there to Calcutta; the fact that he gave his insect the provisional name of *persicus* makes it exceedingly probable that it came from Bushire and not from Calcutta. *M. corticalis* certainly occurs in Persia, for I recently found examples of it among some Carabidae from Seistan in Eastern Persia (Rec. Ind. Mus. xviii, ii, 1919, 101). I have seen no authentic Indian examples of the species. According to Dr. Holdhaus *M. plagiatus* is found in S.E. Europe, the Caucasus, and Turkestan; *M. corticalis* seems more widely spread and occurs throughout the Mediterranean region, Syria, Mesopotamia, and as far as Turkestan.

33. **Dromoceryx dorsalis** (p. 40).

Bates was of opinion (Ann. Mus. Civ. Gen. 1892, 420) that this genus could scarcely be separated from *Metabletus*, and I am inclined to agree with him, though further material is required for investigation. In this species the hind angles of the prothorax are more rounded, the base less produced in the middle, and less emarginate at the sides than is usual in *Metabletus*.

The type is unique, and in poor condition, having lost both antennae and palpi, but the detailed description, especially of the unusual elytral pattern, should make it easy to recognise, when other specimens are found. I have seen no others hitherto.

34. **Dromoceryx angularis** (p. 41). Bates, Ann. Mus. Civ. Gen. 1892, 420.

Two examples. The form of the prothorax agrees well with that of *Metabletus*, in which genus the species should be placed. I have seen no other examples, except the specimen taken by Mr. Fea at Plapu in Tenasserim, and identified by Bates with this species. This I have compared with the two typical specimens. It is about the same size, but rather more convex, and shinier; the head is

darker, and the semilunar common spot on the elytra mentioned by the author is expanded both in front and at the sides, so that it forms a black band across the elytra, wide at the suture and tapering towards the margins; the striae are rather deeper and the intervals, at all events near base, more convex. The upper surface of all the specimens is finely transversely shagreened, and all of them have an umbilicate pore on each side of the scutellum. I hesitate to treat the Plapu example as belonging to another species, and must leave the question in abeyance for the present. It may be mentioned that Bates, though in his paper he indicates no hesitation regarding this determination, has put a note of interrogation on the label.

35. **Microlestes inconspicuus** (p. 41). Bates, Ann. Mus. Civ. Gen. 1892, 419; *id.* Ann. Soc. Ent. Belg. 1892, 233.

The genus was redescribed by Motchulsky (Bull. Mosc. 1847, iii, 219) under the name of *Blechrus*.

There are five specimens in the collection. Bates determined as *M. inconspicuus* examples taken by Mr. L. Fea at Bhamo and Rangoon, and by Père Cardon in Bengal. I have in my collection one of the Bhamo specimens, and have seen another in the collection of the Genoa Museum; both of these agree fairly well with Schmidt-Goebel's types, though the elytra are a little flatter, more aeneous, and less shiny. The solitary brown example from Rangoon may, or may not be an immature example of *inconspicuus*. The abdomen in this species is largely exposed.

Bates also identified with this species his *M. annamensis* (Ann. Soc. Ent. Fr. 1889, 285), but after comparing the two types I am not able to agree with this view. All the five specimens of *inconspicuus* are approximately 3·0 mm. in length, the upper surface—though shagreened—is very shiny, the elytra are moderately convex and with rounded sides; the size of *annamensis* is only 2·5 mm., the upper surface is dull, and the elytra are flat, with nearly straight sides.

36. **Microlestes exilis** (p. 42). Bates, Ann. Mus. Civ. Gen. 1892, 420.

Four examples, all with brown elytra, and nearly resembling each other. Bates records specimens taken by Mr. L. Fea at Bhamo and Rangoon, and I have seen in the collection of the Genoa Museum an example from each of these localities conforming fairly well with Schmidt-Goebel's typical insects. I have also seen a number of

Indian specimens of the size and shape of *M. exilis*, but nearly all have been black or aeneous. An example in my collection from Tharrawaddy (*G. Q. Corbett*), and four examples in the British Museum from Siam are lighter in colour and appear to belong to this species.

Bates compares the species with *M. mauritanicus* Luc., which is unknown to me. It may perhaps be of use if I compare a typical specimen quite briefly with the well-known *M. maurus* Sturm. Slightly smaller, and more slender, joints 1–2 of antennae, apex of palpi, and legs testaceous (but occasionally darker), elytra brown; head with more prominent eyes, prothorax a little narrower, but otherwise of same shape, elytra narrower, sides parallel, surface less shiny, the striae—though still faint—more evident, abdomen exposed.

In this genus the ♂ genitalia have provided distinctive characters, but for purposes of dissection fresher, and also less valuable material is requisite.

37. **Plochionus fenestratus** (p. 42).

A single Burmese example, upon which only two authors appear to have made any comment. In his "Monographie des Callidides" (Ann. Soc. Ent. Belg. 1872, 168) Chaudoir informs us, quite rightly, that the species does not belong to the genus *Plocionus* (as it is now written), and Bates, in his work on Mr. Fea's Burmese Carabidae, says (p. 424) that it appears to belong to the genus *Endynomena*, which is not the case. I find that it actually belongs to Nietner's *Anchista* (Journ. As. Soc. Beng. 1856, vi, 523), a genus omitted by Chaudoir from his monograph. This author, however, dealt with it later on (Bull. Mosc. 1877, ii, 236), though he says nothing about *A. fenestrata*.

Schmidt-Goebel compares his species with *Plocionus bonfilsi* Dej. (= *P. pallens* F.), but had he known the much more nearly allied *Anchista* (*Plocionus*) *binotatus* Dej., I think he would certainly have chosen it for his comparison. *A. fenestrata* is about the same size, though a little narrower, and its coloration is similar, the discal patch on the elytra being rather larger and extending to the base. Head narrower and smoother, the frontal foveae narrower and deeper; prothorax smaller, disk more convex, explanate side margins not quite so wide, but more clearly defined, sides distinctly angled at middle, rather more sinuate before hind angles, sides of base a little more emarginate, median line of similar form, and surface almost identical,

but the front transverse impression is more marked, and there is some little puncturation in its neighbourhood along the front margin; elytra a little narrower and slightly more convex, striae rather deeper and less finely punctate, intervals consequently rather more convex, 3 with three pores, two on disk and one close to apex, 5 with two pores, one close to base, the second at about a fourth from base (in *binotata* 3 has two pores only, one on disk and one near apex, and 5 has a single pore close to base).

38. **Lebia elevata** F. (p. 43) (1919, 178, and 1921, 157).

Three examples from Calcutta, which I have compared with others in my collection from Marseilles and Rouen. I have already discussed this species, which should be known as *Somotrichus unifasciatus* Dej., in my two former papers.

39. **Lebia circumdata** (p. 44). Chaud., Monographie des Lébiides (1), Bull. Mosc. 1870, iii, 224, t. 1, f. 47.

There are four examples in the collection, and a further six indicated as "cotypes," all closely resembling each other. Chaudoir's pattern-figure is fairly good, but shows a little too much yellow at the apex of the elytron. His example was from the Helfer collection. He compares the species with his own *L. gressoria*, and I have only to add that in *circumdata* the sides of the prothorax are slightly sinuate before the hind angles, which are sharply rectangular and stand out more than in Chaudoir's species.

I have in my collection an example from Shwegyin (*G. Q. Corbett*) corresponding exactly with the type specimens. Another example from Kompong Kedey in Cambodia (*R. Vitalis de Salvaza*) has the apical margin very narrowly bordered with yellow, as in one of the typical ones.

40. **Lebia calycophora** (p. 44). Bates, Ann. Mus. Civ. Gen. 1892, 427.

A single example. Chaudoir did not know this species, or either of the two succeeding ones, nor does he comment on them in his monograph. Bates records the fact that Mr. L. Fea took at Thagata in Tenasserim a specimen, which I find to agree perfectly with the type, and also points out that his *Lebia comitata* from Japan (Trans. Ent. Soc. Lond. 1873, 319) is hardly more than a local form. The description is detailed and excellent.

There are a number of examples in the British Museum, viz. two from Burma (*Bowring Coll.*), and others taken by

Doherty in the Patkai and Naga Mountains, Assam, at Momeit, Renong in Siam, and Perak.

41. **Lebia sellata** (p. 45).

Another single specimen, but whether from India or Burma is not known. No one seems to have commented on the species, but I have seen one other example in the British Museum from Momeit (*Doherty*).

In this species the head is very smooth, the prothorax minutely transversely rugose, its sides very gently rounded, hardly contracted behind, without sinuation, the angles about right, but not sharp, a little reflexed, the triangular patch round the scutellum small, ill-defined, and brownish, joined along the sutural interval to a small thick-set cross of St. George, placed just behind the middle, and extending only to stria 4.

42. **Lebia tau** (p. 45).

Five examples, all closely alike, but varying in length from 6 to 8 mm. The description is quite good, and I will only add a few words on the black elytral marking. This reaches the base, except that the scutellum and the region immediately round it are narrowly reddish. The first three intervals on each side of the suture are black to about the middle of the elytra, and joined to this stripe is an irregular black band, reaching to about a sixth from apex, and extending on each side to stria 8. The band is rather broader at the suture than at the sides; its front margin is pushed a little forward on intervals 5–7, and there is a projection on the hind margin, culminating in a tooth on interval 3.

Bates missed an identification here and redescribed the species under the namo of *L. maharani* (Ann. Mus. Civ. Gen. 1892, 427); his examples, which came from Bhamo (*L. Fea*), are equal to the largest type. I also identify with the species an example in the British Museum from Momeit (*Doherty*), but it is a little smaller than the smallest typical specimen, and the elytral intervals are rather flatter.

43. **Physodera dejeani** Eschscholtz, Zool. Atlas, ii, 1829, 8, t. 8, f. 6 (p. 46).

There are four examples of this species from Tenasserim. I have seen the type in Mr. René Oberthür's collection, but unfortunately had no specimen with me for comparison. I have no reason to doubt the correctness of Schmidt-Goebel's identification. The figure given by Eschscholtz, though not well executed, is recognisable;

a better one is given by Lacordaire (Gen. Col. Atlas, t. 4, f. 3). There are in this genus two supraorbital sitae on each side, and the clypeus is bisetose; the front margin of the prothorax is setose, and there are one or two fine setae in the neighbourhood of its hind angles. The number and position of the pores on interval 3 in *P. dejeani* seem to be a little variable, but generally there is one rather before middle, and one (sometimes two rather close together) at about a fifth from apex; there is also a well-marked pore near the base of interval 5.

Eschscholtz's type came from Manilla, and I have seen other examples from Java, Sumatra, and the Andaman Is.

So far as I am aware no explanation has yet been offered of the remarkable yellow lobes on each side of the prothorax, or of the yellow markings, both above and below, on the sides of the last abdominal segment.

44. **Pentagonica ruficollis** (p. 48). Bates, Trans. Ent. Soc. Lond. 1873, 320; *id.* Ann. Soc. Ent. Fr. 1889, 286; *id.* Ann. Mus. Civ. Gen. 1892, 426; Dupuis, Gen. Ins. Pentagonicinae, t. f. 5, and 9–11.

A unique and unfortunately poorly preserved specimen, but one which requires rather extended comment.

In 1873 Bates identified as *P. ruficollis* some specimens taken by Mr. George Lewis in Japan, but in 1892 he recognised that these belonged to another species, to which he gave the name of *P. daimiella*.

In 1889 Bates dealt with a number of Carabidae taken in Indo-China by Capt. de la Perraudière, and among them was a single specimen of *Pentagonica*, which he determined as *P. ruficollis*. Thanks to Mr. E. Fleutiaux I have been able to examine this and find it to be quite distinct, but it may prove to belong to one of the other described species, the types of which I have not yet seen, so I refrain at present from giving it a new name.

In 1892, when engaged upon the large collection of Carabidae formed by Mr. L. Fea in Burma, Bates discussed this species, and identified with it a solitary specimen from Rangoon. I have compared this with the type, and, in so far as the form of the prothorax goes, Bates' remarks are quite correct. The elytra, however, are striate-punctate, with the punctures quite clear, whereas in the type they are scarcely visible: the Rangoon insect is also smaller. For the present I can only treat this specimen as a " variety " of Schmidt-Goebel's species.

Other and closely allied examples taken by Mr. Fea at Karin Cheba Bates identified with his own *P. nigripennis* (Trans. Ent. Soc. Lond. 1873, 320) from Japan. I have in my collection several of these examples and also a cotype of the Japanese species, which I find on examination to be quite distinct. The head and prothorax do not differ greatly, though in *nigripennis* the latter is a little narrower and has the side angles a little more rounded. The chief difference is in the elytra, which in the Japanese form are convex, rounded at the sides, the striae only faintly impressed, with very distinct fine punctures, intervals almost flat, surface very smooth and polished, margin narrowly rufescent. In the Burmese species, for which I suggest the name of *P. batesi*, the elytra are relatively flat, the sides less rounded, the striae clearly and rather irregularly, though not deeply impressed, the punctures less conspicuous, intervals more convex, surface finely shagreened, though moderately shiny, and margin with a very evident testaceous border. Interval 3 in both species has three minute pores, as is also the case in *P. ruficollis*, but the two hind ones are generally indistinct.

In 1893 (Proc. Linn. Soc. N.S.W. 636) Mr. T. G. Sloane published, under the name of *P. dichroa*, the description of a species of this genus taken in Queensland. Mr. Sloane has kindly sent me a specimen of this, together with the type for examination; I find it to be very near to, probably identical with, Schmidt-Goebel's species. In the Australian insect the condyliform neck is black, joints 3–4 of the antennae reddish, the elytra a little longer, the striae shallower, with rather finer and more visible punctures, the intervals distinctly less convex, the testaceous margin a little narrower. In *ruficollis* the neck is red; only joints 1–5 of a single antenna remain, but these appear to be fuscous, the apex of joint 2 only being red. In spite of the differences noted above, I think it will be difficult to keep the species apart, and myself propose to treat them as identical.

In his work on the Pentagonicinae Commandant Dupuis figures the underside and the legs of *P. ruficollis*. I do not know from what example these drawings were made, and the condition of the type does not allow me to verify their correctness.

I am able to place on record some further localities for the species: Aratapara in the Nilgiri Hills, "on sand, riverside, 2500 feet, December" (*H. L. Andrewes*); Hoabinh

in Tonkin (*R. Vitalis de Salvaza*); Sumatra, "Mana-Riang, Ranau, Palembang, 2000–3000 feet (*I. Z. Kannegieter*)"; Borneo, Doesonlanden (*Wahnes*), in Mr. Sloane's collection; Assam, Patkai Mountains (*Doherty*), in the British Museum.

45. **Pentagonica erichsoni** (p. 48).

Another single example, also poorly preserved, and like the last probably from Burma. I cannot find that any one has hitherto identified this species.

Schmidt-Goebel says that the front margin of the prothorax is straight, but it is actually slightly and widely emarginate. The whole upper surface is very finely shagreened, the head and prothorax dull, the elytra moderately shiny. Once again the author reports two punctures on interval 3, whereas there are actually three, all clearly visible.

I have in my collection an example taken by Mr. G. E. Bryant on Mount Matang, West Sarawak; in this the legs, the margins of prothorax and elytra, and joints 3–4 and the apex of joint 2 of antennae are testaceous, the other joints black. Schmidt-Goebel tells us that the type had only the two basal joints of the antennae, which were pitch-black, when he described it; it has now only the basal joint.

Mr. H. Stevens has also taken four examples at Gopaldhara, British Sikkim, which I refer to this species. In one of these joints 3–4 of the antennae are testaceous, in two other examples the whole antenna is testaceous, except the basal joint, and in the fourth the antennae are entirely fuscous. In three of the examples the margin of the prothorax is only very slightly tinged with yellow, and in two of them the femora are fuscous. The coloration of these parts does not appear in this species to be of specific importance.

Other localities are: Manipur (*Doherty*) in the British Museum; Kurseong, 5000 feet (*C. A. Paiva*) in the Indian Museum; "Selangor-Pahang, Semangko Pass" in the Raffles Museum, Singapore.

46. **Hexagonia Kirbyi** (p. 51, Tab. II, fig. 2). Van de Poll, Notes Leyd. Mus. xi, 1889, 250; Bates, Ann. Mus. Civ. Gen. 1892, 366.

Schmidt-Goebel discourses at length upon this genus, and *H. terminata* Kirby, its type, which I redescribed in a former paper (1919, 132). Compared with this,

H. Kirbyi has the dark apical patch on the elytra less clearly defined (much less than in the figure), and the striae less impressed, the genae longer and more rounded, the general coloration a little lighter. The author says that there are two indistinct punctures on interval 5: I find on the contrary that there is only one at about the apical third, and that very well marked. The figure is quite a fair one, but the prothorax is too long.

The unique type is believed to have come from Darjiling or Calcutta, and Kirby's type may very likely have come from North Eastern India. Van de Poll mentions two examples from Java (*Lucassen*), which I have not seen. Bates records a single example from Palon in Pegu (*L. Fea*), which agrees very well with the type, though the line dividing the colours on the elytra is much more clearly defined.

I have in my own collection an example from North Kanara in Bombay (*T. R. D. Bell*) and four examples from Tharrawaddy in Burma (*G. Q. Corbett*). In these there are noticeable, if slight, differences in the shape of the head, the colour of the prothorax, the depth of the elytral striae, and the proportions of the two colours on the elytra. After comparing them with Schmidt-Goebel's and Kirby's types, I am disposed to think that we have to do with a variable species, and that all these specimens, including the type of *H. Kirbyi*, are to be referred to *H. terminata*.

47. **Hexagonia apicalis** (p. 51). Dupuis, Gen. Ins. Hexagoniinae, t. f. 11.

A single specimen, which like the last is supposed to have come from Darjiling or Calcutta. Commandant Dupuis gives a figure, alleged to be *H. apicalis*, but the artist, if he had the type before him, has not been very successful in representing it.

I have not come across any other example; the description is satisfactory, but the antennae are longer than is indicated, reaching to about the basal fourth of the prothorax, and there are evidently normally three punctures on interval 3, though in the type the hind puncture on the left side is wanting.

I take this opportunity of referring to a structural character in the genus *Hexagonia*, upon which Entomologists in past years have expressed diametrically opposite opinions. One of the characters distinguishing the Cicindelidae from the Carabidae is the presence in the former (except in

Pogonostoma and *Ctenostoma*) of an articulated tooth at the apex of the maxilla, which is wanting in the latter. When Kirby described *Hexagonia* in 1825 (Trans. Linn. Soc. xiv, 563) and Dejean in 1831 redescribed it under the name of *Trigonodactyla* (Spec. Gen. v, 288), neither author made any special mention of the maxillae. In 1834 Brullé (Audouin and Brullé, Hist. Nat. Ins. iv, 227) gives Audouin as his authority for the statement that in *Trigonodactyla* the maxilla is provided at the apex with an articulated tooth, and this was confirmed by Schmidt-Goebel (p. 49) in his redescription of *Hexagonia*. Lacordaire (Gen. Col. i, 1854, 69) quotes both these authors, but did not apparently have the opportunity of testing their statements. The next author to refer to the matter was Dr. G. H. Horn (Trans. Amer. Ent. Soc. 1881, 146), who informs us that he "dissected the mouth of *Trigonodactyla*," and examined the parts under the microscope. He does not expressly say what he saw, but he gives a figure of the maxilla, and by implication denies the statements of Audouin and Schmidt-Goebel, adding "it is remarkable that such an extraordinary error should have been allowed to pass current from one author to another as has been done in the description of the maxilla." The only other author I have to quote is Commandant Dupuis (Gen. Ins., *Hexagoniinae*, 1913, 1), who says: "Une singulière erreur, provenant d'un examen superficiel des parties buccales, a été longtemps accréditée en ce qui concerne les *Hexagonia*. On les décrivait comme ayant le lobe interne des mâchoires terminé par un crochet mobile, comme celui des Cicindèles. Horn, le premier, s'est aperçu de l'inexactitude de cette constatation. La figure des mâchoires permettra de comprendre la confusion qui a pu se produire." The figure in question seems to be a reproduction on a larger scale of that given by Horn.

With a view to testing these various statements I dissected the mouth-parts of *Hexagonia terminata* Kirby (Burma) and *H. terminalis* Gemm. and H. (S. Africa), but my specimens were old and I could not satisfy myself regarding the mobility of the apical hook. On dissecting a rather larger species, *H. nigrita* van de Poll (Indo-China and Sumatra), I was able to convince myself by manipulation that the apical hook was actually mobile. Another example, of an undescribed species lately taken by Mr. H. Stevens in Sikkim, happens to have one of the maxillae widely opened,

and here again the apex proved to be movable. As a further check I invoked the assistance of Dr. J. Waterston, who has been good enough to dissect the mouth-parts of another example of *H. terminata* and prepare them for the microscope, with the result that he quite confirmed the fact of the mobility of the apical hook; Mr. T. G. Sloane has also been kind enough to check my observations, and has arrived at the same conclusions. There is certainly a functional joint between the two parts, but I am not prepared to say that it is a normal joint.

In the allied genus *Omphreoides*, which seems to represent *Hexagonia* in Madagascar, but differs in the enormous size of the head and the mucronate elytra, the maxillae are wide, flat, and very thin at the apex, which, as in *Hexagonia*, is externally densely pilose; here again the apex is clearly mobile, though I cannot detect any actual joint. Schmidt-Goebel quotes Erichson as affirming the presence of a similar mobile hook in the maxillae of another allied genus *Leptotrachelus*, but both he himself and Chaudoir dissented from this view. I have dissected examples of *Leptotrachelus testaceus* Dej. (Columbia) and *Ctenodactyla batesi* Chaud. (Amazons) without finding any mobility in the apical hook.

The above considerations seem to confirm the close relationship between the Carabidae and Cicindelidae, but until something is known of the life-history and especially the larval stages of the species of *Hexagonia*, it would be unwise to make too much of this character, so entirely exceptional in the Carabidae.

48. **Euplynes cyanipennis** (p. 52). Chaud., Ann. Soc. Ent. Fr. 1859, 350; *id.* Ann. Soc. Ent. Fr. 1878, 376; Bates, Ann. Mag. Nat. Hist. (5), xvii, 1886, 147.

There are four examples in the collection, and two more in the Nickerl collection (now in the Prague Museum), all from Tenasserim. I have already published some notes on this species (1919, 164). Chaudoir quite misconceived the genus, which he had evidently never seen. Bates knew it, but I am not aware whether he was acquainted with Schmidt-Goebel's species; at all events it was not among those taken by Mr. Fea in Burma.

The genus seems to be an extreme form of *Colpodes*, in which all the tarsi are strongly and equally bilobed. The description is quite explicit and hardly needs further comment. Superficially there is a strong resemblance to *Colpodes ruficeps* Macl., but in that species joint 4 of the

tarsi is unequally and also less evidently bilobed in the two front pairs, emarginate only in the hind pair, and the depression on the elytra is placed further back.

There are examples in the British Museum from the Andaman Is., Celebes, Batchian, Gilolo, and a solitary specimen labelled " India."

49. **Coptodera interrupta** (p. 53). Chaud., Mémoire sur les Coptodérides, Ann. Soc. Ent. Belg. xii, 1869, 194; Bates, Ann. Mag. Nat. Hist. (5), xvii, 1886, 203; *id.* Ann. Mus. Civ. Gen. 1892, 411.

The species of this genus seem to have been more erroneously determined by subsequent authors than those of any other genus with which Schmidt-Goebel dealt. Of the four species described Chaudoir, in his Memoir, correctly identified *C. flexuosa*, misidentified *C. interrupta*, and neglected the other two altogether. Bates also identified *C. flexuosa* correctly, but his two identifications of *C. interrupta* not only differ *inter se*, but are both inaccurate, while, as I anticipated, *C. elegantula* Bates (not Schm.-Goeb.) = *C. interrupta* Chaud. (not Schm.-Goeb.). I must qualify this statement regarding the specimens taken by Mr. Fea in Burma and determined by Bates as *C. interrupta*. These came from Teinzo, Shwegü, Palon, and Kawkareet, and I have seen four of them, viz. three from Palon and one from Kawkareet. One of the Palon examples and that from Kawkareet are correctly determined, but the other two examples from Palon belong to *C. transversa*, as mentioned under that species.

There are three examples in the collection, all much alike. The description is unusually long and detailed, and on only one point does it seem necessary to supplement it. This is in reference to the setiferous punctures on interval 3, a weak point in several of the descriptions. The author says that there are two deep punctures on interval 2, but there are actually three on interval 3, one near the base, one at three-fourths, and one quite close to the apex. These punctures are identical in all the specimens (including varieties) which I have seen. The yellow spots, on the contrary, are very variable. The front one is generally a little transverse, bulging slightly in front, and emarginate behind. The hind spot is more or less oblique and very irregular; the yellow colour on 1–3 is much behind that on 5–8, while on 4 it is elongate, common to both parts, and extends furthest towards apex.

The species is widely spread: Namsu, Nurbong, and Birik (*H. Stevens*), also Pashok (*F. H. Gravely* and *R. C. Hartless*), all in Sikkim; Dehra Dun, Thano, "under sál bark"; Nilgiri Hills (*H. L. Andrewes*); Ceylon (*Thwaites*); Burma, Tharrawaddy (*G. Q. Corbett*); Malay Peninsula (*M. Cameron*); Sarawak, Mount Matang and Quop (*G. E. Bryant*), also Kusing Hill (*G. D. Allen*); Nam Tha, Vien Poukha, Ban Silah, Xieng Khouang, and Muong You, all in Laos (*R. Vitalis de Salvaza*). The specimens from the Malay region have larger spots, the front one more rounded; in that from Quop the prothorax is testaceous, with a dark stripe down the middle. The Indo-Chinese examples are larger and darker, with larger spots. I do not consider *C. japonica* Bates as more than a local form.

The only species with which *C. interrupta* is likely to be confused is *C. transversa*, but that species has a much wider prothorax, the punctures on interval 3 are differently placed, the hind spot transverse, its various parts more or less on the same level, the colour on interval 5 pushed a little forward, so that the spot bulges there in front and is emarginate behind.

For *C. interrupta* Chaud. (= *interrupta* Bates Ann. Mag. Nat. Hist. (5), xvii, 1886, 203 = *elegantula* Bates Ann. Mus. Civ. Gen. 1889, 111, and 1892, 411) I propose the new name *C. eluta*. I have seen examples determined by both these authors. Chaudoir has already given a description (Memoir, p. 194), but omits all reference to the punctures on interval 3. These are four in number: first near base, second at about a fourth, third a little behind middle, and fourth close to apex. Chaudoir gives as localities Borneo (*Wallace*), Ceylon (*Nietner*), and Siam (*Castelnau*). Bates mentions Bhamo, Teinzo, and Thagata in Burma (*L. Fea*), Ceylon, Malacca, and Sumatra. To these I am able to add Bengal, Khasi Hills in Assam, Port Blair in the Andaman Is. (*S. W. Kemp*), Penang (*Lamb*), Tonkin and Laos (*Mouhot* and *R. Vitalis de Salvaza*), Philippine Is. (*Whitehead*), Amboina, and Timor.

50. **Coptodera elegantula** (p. 54). Bates, Ann. Mus. Civ. Gen. 1889, 111; *id.* Ann. Mus. Civ. Gen. 1892, 411.

Schmidt-Goebel's solitary example hardly differs at all from his *C. interrupta*, and is without doubt the same species. The example is a little smaller, the punctures on interval 3 identical, the front spot squarer and only slightly indented behind, the hind one of exactly the same

shape and size. I have already given a new name to Bates' species (see under *C. interrupta*).

51. **Coptodera transversa** (p. 54).

I have found no references to this species, except one by Chaudoir (Memoir, p. 164), which is not of any great assistance. The species is, I find, identical with *C. bicincta* Chaud. (not Hope) (Memoir, p. 187), to which I gave the name of *C. chaudoiri* (1919, 179), now superfluous.

As two descriptions have been published, and I have already compared the species briefly with *C. interrupta*, I have only to add that there are four setiferous pores on interval 3, two rather close together near the base, the third a little behind middle, and the fourth not far from apex, though much further away than in *C. interrupta*. (The author says there are three pores on interval 2.) All four pores are clearly visible in the unique type, but, in some other specimens I have seen, the second one is wanting.

This is the species some examples of which were taken at Palon in Burma by Mr. L. Fea, and referred by Bates to *C. interrupta* (see under that species). I am able to add the following localities: Nilgiri Hills, " out of a toadstool " (*H. L. Andrewes*); Orissa, Gopkuda I. and Barkuda I. in Lake Chilka (*F. H. Gravely*); Bengal; Dehra Dun, " under sâl bark "; Laos, Nam Hou and Sala San Tiot (*R. Vitalis de Salvaza*); Hong-Kong (*Bowring*).

52. **Coptodera flexuosa** (p. 55). Chaud., Memoir, p. 196; Bates, Ann. Soc. Ent. Fr. 1889, 283; *id.* Ann. Mus. Civ. Gen. 1892, 412.

Another unique example. Schmidt-Goebel says there are two punctures on interval 2, but there are actually four on interval 3, viz. two not far from the base or from each other, the third at about two-thirds, the last—as in *C. interrupta*—quite close to apex. I have seen no examples in which any of these pores have been wanting.

The species is common and widely spread throughout S.E. Asia, especially in the Malay Archipelago, but does not apparently extend to China or Japan.

53. **Orthogonius deletus** (p. 56). Chaud., Essai monographique sur les Orthogoniens, Ann. Soc. Ent. Belg. xiv, 1871, 113.

Four examples in the collection, all labelled Tenasserim. Chaudoir had in his collection another specimen taken by Helfer, and gives a description of it in his Monograph. Bates did not recognise the species among those taken by

Mr. L. Fea, but it turns out that he actually redescribed it under the name of *O. quadricollis* (Ann. Mus. Civ. Gen. 1892, 400); the specimens in this case came from Karin Cheba and Palon in Pegu. Two further examples in my collection were taken by the late Mr. G. Q. Corbett at Tharrawaddy.

The three descriptions already published leave little more to be said. I am inclined to think that in this genus the ♂ genitalia, not much used hitherto in the oriental genera as a character for differentiating species, may in this genus prove useful. In *O. deletus* the ocdeagus is rather short, slightly curved, pointed at extremity, but with the tip rounded off.

54. **Orthogonius puncticollis** (p. 57) (1921, 165).

This species, as I anticipated, proves to be identical with *O. duplicatus* Wied., and I do not propose here to repeat my comments on that species. The solitary example came from Martaban. The oedeagus hardly differs in form from that of the preceding species.

55. **Orthogonius profunde-striatus** (p. 58). Chaud., Mon. 112; Bates, Ann. Soc. Ent. Fr. 1889, 280; *id.* Ann. Mus. Civ. Gen. 1889, 110, and 1892, 399; *id.* Compt. rend. Soc. Ent. Belg. 1891, 338.

Schmidt-Goebel mentions two examples from Tenasserim, but there are actually three. Chaudoir treated the species as identical with *O. puncticollis*. Bates was at first inclined to consider it distinct, but later on came to the same conclusion as Chaudoir. After a comparison of types, I agree with them.

56. **Orthogonius angulatus** (p. 58). Chaud., Mon. 110; Bates, Ann. Mus. Civ. Gen. 1892, 401.

There is a good deal of difference in the appearance of the two specimens. One of them is rather dark brown, very dark at base and sides of elytra; the prothorax moderately contracted behind, the elytral striae fairly deep, intervals convex and distinctly punctulate. The elytra of the second specimen are of a uniform light brown, the head and prothorax darker; the prothorax but little contracted behind, the elytral striae shallow, intervals more nearly flat and rather indistinctly punctulate.

Chaudoir did not know this species, but Bates identified with it two specimens in the Fea collection taken at Karin Cheba; I have seen one of these which is now in the collection of the Genoa Museum.

Chaudoir thought the species would fit into the *fugax*-group of his Monograph. Bates, on the other hand, thought it might be placed in the neighbourhood of *O. hopei* Gray and *O. acrogonus* Wied., but he evidently failed to examine the ligula and paraglossae. In most of the examples which I have examined of this and of the next species, *O. plicatus*, which seems to me to differ only in the vermiculate surface of the head, the ligula is quadrisetose. In one of the typical examples of *plicatus* it is clearly sexsetose, and, as these setae are easily abraded, I think it probable that it is really sexsetose in all. The paraglossae are wide, extend beyond the ligula, and are obliquely truncate at apex, which is more or less setose. These characters are those of Chaudoir's genus *Hexachaetus* (Mon. 124), to which, so far as present indications go, I think the species should be referred.

Neither the author nor Bates mentions that in this species the ♂ intermediate tibiae are inflated, as in *O. crassicrus* Chaud. The oedeagus is small, bluntly pointed, and slightly constricted before apex.

I have in my collection two examples from Maymyo (*H. L. Andrewes*), agreeing well with the typical specimens, as does an example from Perak (*Doherty*) in the British Museum. Other examples, also in the British Museum, from Penang (*Lamb* and *G. E. Bryant*) differ in their wider form and flatter elytral intervals.

57. **Orthogonius plicatus** (p. 59). Chaud., Mon. 110.

Two examples from Tenasserim. The species was unknown to Chaudoir and no other author has referred to it. As mentioned above, the vermiculate surface of the head (a very variable character) alone distinguishes this species from the last, and this is also characteristic of the genus *Hexachaetus*. I think the two species are identical, but that in *O. angulatus* this particular character is more or less obsolete. Both of them have a deep rounded fovea in the middle of the clypeus.

I have one example of the species from Maymyo; this was taken by Mr. H. L. Andrewes on the same visit to Burma, but not on the same day as the two specimens mentioned above. I have also seen three examples from Tonkin and Laos (*R. Vitalis de Salvaza*), which are quite black.

58. **Orthogonius sulcatus** (p. 59). Chaud., Mon. 110; Bates, Ann. Mus. Civ. Gen. 1892, 403.

Two examples from Tenasserim. Chaudoir did not know the species: Bates was inclined to identify with it his *O. rufiventris*, but I find, on a comparison of types, that the two species are quite distinct.

Superficially this species is rather like *O. angulatus*, but of a deep brown red colour. The ligula is bisetose, the clypeus smooth, with a deep suture, and some fine irregular striation on vertex, the antennae reaching rather beyond base of prothorax. The hind angles of the prothorax are obtuse, but very little rounded, the width quite twice the length, the base bisinuate, the basal foveae deep and round, the surface convex and shiny. The elytra are convex, nearly parallel, and shiny; the author says that there are, as in the two preceding species, two punctures on interval 3, but actually there are three, the median puncture against stria 2 being very distinct. The intervals are of equal width, but 7 is narrower and more convex towards base. The prosternal process is distinctly bordered, the protibiae produced externally at apex, the mesotibiae slightly curved, crenulate externally and also produced at apex, the metatibial spurs spathulate, joint 4 of the tarsi bilobed throughout and all claws pectinate.

There is in the British Museum a single specimen from Cambodia, which agrees well with the typical examples. Judging by the description, Chaudoir's *O. crenaticrus* (Mon. 113), which also came from Cambodia, belongs to this species.

59. **Orthogonius alternans** Wied., Zool. Mag. ii, 1, 1823, 52 (p. 60) (1921, 170).

The solitary example from Tenasserim agrees quite well with the one I compared with Wiedemann's type.

60. **Orthogonius opacus** (p. 60).

One specimen from Tenasserim. Chaudoir, although professing to write a Monograph of the genus, does not even mention this species, nor has any other author referred to it.

I find it to be the same as Bates' *O. apiculatus* (Ann. Mus. Civ. Gen. 1892, 403) from Karin Cheba (*L. Fea*), of which I have cotypes in my collection. As Bates points out, the species is closely allied to *O. insularis* Chaud., but that is much smaller and otherwise coloured. The ligula is very narrow at apex and bisetose, the oedeagus elongate and bluntly pointed. The ♀ seems on average to be larger than the ♂, and with the surface of the elytra duller.

There are examples in the British Museum from Tenasserim, the Shan States (*Manders*), and the Andaman Is. (*Capt. Wimberley*). In the Indian Museum are others from Sikkim, Pashok, 3500 feet (*F. H. Gravely*) and Kurseong, from Assam, Garo Hills, Tura, 3500–3900 feet (*S. W. Kemp*), and from the Andaman Is. Mr. H. Stevens has lately taken numerous specimens at Gopaldhara, 4720 feet, in Sikkim.

61. **Orthogonius angusticollis** (p. 61). Chaud., Mon. 122.

A single example from Tenasserim. Chaudoir did not profess to know the species, but he includes it in his Monograph, and puts it, quite erroneously, among the species having a quadrisetose ligula. I can see nothing to differentiate this specimen, which is a ♂, from ♂ specimens of *O. opacus* taken by Mr. Stevens in Sikkim, the width of the prothorax being evidently a very variable character. The explanate margin of the prothorax is much wider behind, not equally wide throughout as stated by the author, and the re-entrant angle at the apex is unusually deep. I regard the species as identical with the previous one.

62. **Apsectra duplicata** (p. 61) (1921, 166). Chaud., Mon. 99.

According to the author there should be two specimens, but there is only one, a ♂, labelled " Tenasserim." Schmidt-Goebel thought his species was the same as *O. duplicatus* Wied., but, as I have pointed out elsewhere, it is quite different, and Chaudoir, although he did not know the species, was quite right, not only in changing the name to *Schmidt-Goebeli*, but also in referring it to the genus *Orthogonius*. Schmidt-Goebel founded his genus upon the fact that in the species under consideration the claws are simple, but in *Orthogonius* this is a variable character and cannot be considered as of generic value. The species is singularly like *O. alternans* Wied., though the sides and hind angles of the prothorax are less rounded. Apart from the simple claws, one of the chief differences is in the form of the oedeagus, which is rather short and sharply recurved, truncate at apex, the front part of the truncature a little produced and very sharp, the hind part rounded.

There is a second example of this species in the British Museum, the only other one I have seen; it came also from Tenasserim.

63. **Dolichoctis striata** (p. 62). Chaud., Mon. sur les Coptodérides, Ann. Soc. Ent. Belg. xii, 1869, 246.

The solitary example was in poor condition when described; I may add to the characters mentioned that the base of the prothorax is slightly produced in the middle, the median line is clearly marked, and interval 3 of the elytra has two minute pores, one at about a half, the other at three-fourths. There is a faint apical spot on the elytra, not mentioned in the description, and even a suggestion of a shoulder spot.

Chaudoir identified with this species a specimen taken by Wallace in the Aru Is., and there are others in the collections of the British and Oxford Museums, and in my own from the Aru Is., New Guinea, Celebes, Mysol, Buru, Batchian, and Salwatty.

In the type the prothorax is very wide, and its sides more rounded than in the other examples. It differs little from No. 80 *Mochtherus rotundatus*, which also belongs to this genus, but it is wider, and the red spots are reduced or wanting; the prothorax (in the type) is wider, with obtuse hind angles, very little reflexed, the elytral striae much finer. In Chaudoir's specimen the front pore on interval 3 seems to have been wanting. It may prove that *D. striata*, *M. rotundatus*, and the other forms referred to under the latter all really belong to one variable species.

64. **Scalidion hilare** (p. 64).

No one, so far as I know, has referred to this genus or species. As pointed out by Schmidt-Goebel, it is not far removed from *Orthogonius*, but the truncate, quadrispinose apex of the elytra, and the peculiar form of interval 8, which is much enlarged behind and irregularly bistriate on the apical third, distinguish it at once from that genus. On interval 4 there are normally four large setiferous pores, but one example I have seen had six pores on the left elytron.

The type is unique and came from Burma, but I have seen three other examples, one from Dehra Dun, Harrawala, the second without any locality label, but probably from Dehra Dun, the third from Sonapur in Assam (*L. G. Middleton*).

I cannot satisfactorily separate from *Scalidion* Bates' genus *Aristolebia* (Ann. Mus. Civ. Gen. 1892, 428), made for a species, *A. quadridentata*, found at Bhamo and in Assam. I have not been able to detect in *S. hilare* the two

teeth at the apex of the intermediate tibiae, but this is a ♂ character and all the four examples I have seen are apparently ♀♀. The form is nearly the same, but the base of the prothorax, which in *quadridentata*, is slightly lobed, is in *hilare* practically truncate; in the former species there are only two pores on interval 3, and interval 8 is normal. Both species present the remarkable character of a single large setiferous pore on the middle of the prosternal process, and the ligula seems identical, dilated towards apex, with a rounded angle in the middle, beneath which are two long setae, the apical margin densely setose, the paraglossae adnate. In *hilare* the tooth of the mentum is rather blunt, the tarsi are very slightly pubescent above, and joint 4 is distinctly bilobed, but the serrate claws are identical in the two species; the last ventral segment (♀) is emarginate and there are three setiferous pores on each side, whereas in *quadridentata* (♂) it is straight and there are but two. In both species the ventral surface is moderately pubescent.

Lebia xanthophana Bates (Proc. Zool. Soc. Lond. 1888, 382, and 1889, 218) from South China appears to be an *Aristolebia*, and *Sarothrocrepis mucronatus* Sl. (Proc. Linn. Soc. N.S.W. 1907, 374) from Queensland belongs, as Mr. Sloane informs me, to the same genus. I am indebted to Mr. Sloane for a specimen of yet another species, at present undescribed, from New Guinea; this is a ♂ and shows very clearly the two teeth on the intermediate tibiae.

65. **Macrochilus tripustulatus** (p. 65).

Schmidt-Goebel cites this as Dejean's species, recognising that the Fabrician insect was something quite different. It is actually *M. trimaculatus* Oliv., but I have dealt fully with this species in previous papers (1919, 129 and 176; Ann. Mag. Nat. Hist. (9), vi, 1920, 497 and 502), and need not go over the ground again.

66. **Eustra plagiata** (p. 66, Tab. III, fig. 1). Chaud., Bull. Mosc. 1854, ii, 310; *id.* Ann. Soc. Ent. Belg. xi, 1868, 71; Bates, Trans. Ent. Soc. Lond. 1873, 237; *id.* Ann. Mus. Civ. Gen. 1892, 269; Lewis, Ann. Mag. Nat. Hist. (6), xvii, 1896, 330; Dupuis, Ann. Soc. Ent. Belg. 1913, 418; Andr., Ann. Mag. Nat. Hist. (9), iv, 1919, 295 and 299.

Chaudoir knew this species and indeed had in his collection one of the Helfer specimens. Bates' reference in

1873 was to a different one (*E. japonica*), as he saw when in 1892 he had examples of Schmidt-Goebel's species before him. Mr. Lewis gives some interesting notes on the habits of the Japanese insect. Commandant Dupuis reports both of them from Formosa.

In 1919 I published a note on the Eastern Ozaenini, with a key to the genera and to the species of *Eustra*. An examination of Schmidt-Goebel's two typical specimens, though I have not been able to see the buccal organs as well as I could wish, serves to confirm what I have said. I must add, however, that the difference indicated in the border of the prothorax as between *E. plagiata* and its allies is of degree only and not of kind. In the typical specimens there is a row of very minute tubercles (no doubt setiferous) along the border, which give a faintly crenulate, though not dentate appearance to the outline. In the figure the eyes are too prominent, and the notch in the margin of the elytra is insufficiently indicated.

The typical specimens are 2·5 mm. in length, and an example in my collection from Palon (*L. Fea*) measures 3·0 mm.; I have also seen examples in the collection of the Genoa Museum both from Palon and Teinzo. The former agrees with my example and with the type, though the head is testaceous. The Teinzo example, like the others, is larger than the type, and the elytra, except margins and suture, are fuscous; it is also abnormal in having the surface of the elytra aciculate rather than punctate, but I hesitate to consider it as more than an aberration. Two further examples from the Ouchterlony Valley, Nilgiri Hills (*H. L. Andrewes*) are 3·5 and 4·0 mm. long respectively, but, though so much larger, they appear to belong to the same species.

67. **Itamus castaneus** (p. 67). Chaud., Bull. Mosc. 1854, ii, 297; *id.* Ann. Soc. Ent. Belg. xi, 1868, 51; Bates, Compt. rend. Soc. Ent. Belg. 1891, 326; *id.* Ann. Mus. Civ. Gen. 1892, 269; Andr., Ann. Mag. Nat. Hist. (9), iv, 1919, 295–6.

The species was apparently unknown to Chaudoir, but it is recorded by Bates from various localities. This genus, like the last, was included in my notes on the Eastern Ozaenini; an examination of the unique type, which is a little larger and darker than other specimens in my collection, enables me to confirm the characters given in the key to the genera. I find, however, that the front margin

of the labrum, including the two outer setae, which are placed a little further back than the others, may be either 8- or 10-setose, the latter in the type.

Bates gives as localities several places in Burma, viz. Bhamo, Katha, Prome, and Mandalay (*L. Fea*), to which I can add Pyinmana, Kaing River (*C. F. C. Beeson*). I have in my collection one of the Prome examples, and in the collection of the Genoa Museum I have seen another from the same locality (11·0 mm. in length, labrum 10-setose), and one from Bhamo (13·0 mm. in length, labrum 8-setose), all agreeing very well in general structural characters with the type. Bates also mentions a specimen taken (presumably) in Bengal, and another from the Andaman Is. The habitat extends as far as Laos, where it has been taken at Ban Houei Soui and Xieng Om (*R. Vitalis de Salvaza*). There is a specimen labelled "East Indies" in the Oxford Museum.

68. **Mastax elegantulus** (p. 69, Tab. II, fig. 1). Chaud., Monographie des Brachynides, Ann. Soc. Ent. Belg. 1876, 99.

Chaudoir did not know any of the three species of *Mastax* described by Schmidt-Goebel, though he refers to all of them in his Monograph. *M. elegantulus* does not seem to have been mentioned by any other author. The type is unique, and bears the label Tenasserim: it is in good condition and the author's description is long and exact. The figure gives quite a good idea of the insect, but joints 4–11 of the antennae and the tarsi should be fuscous, and the testaceous shoulder rings should unite over the scutellum. In the type, as in the plate, the arms thrown out by the front and hind bands do not quite join at the middle, but normally they are connected.

I have seen no other Burmese examples, but the species has been taken fairly commonly by Mr. H. Stevens in Sikkim at Gopaldhara, between 3400 and 4700 feet, and there is an example in the Indian Museum, also from Sikkim, taken by Mr. F. H. Gravely at Kalimpong.

69. **Mastax moestus** (p. 70, Tab. II, fig. 3). Chaud., Mon. 100; Bates, Ann. Mus. Civ. Gen. 1892, 399.

There are three typical specimens, not quite alike, all labelled Tenasserim. The description is accurate, but joint 4 of the antennae is largely testaceous and the suture of the elytra is dark red. The figure gives quite a fair idea of the elytral pattern, except that the testaceous

shoulder rings should be wider in the neighbourhood of the scutellum: the elytra also are a little too wide, and joints 5–11 of the antennae ought to be fuscous. The longitudinal striation of the prothorax is very poorly done. Schmidt-Goebel says that the three raised intervals are 2, 4, and 6, but he does not reckon the sutural interval, and we should now call them 3, 5, and 7.

Bates identified with this species examples taken by Mr. L. Fea at Palon in Pegu. I have seen two of these, now in the Genoa Museum, and find them to conform very well to the typical specimens. I have seen no other examples.

70. **Mastax ornatus** (p. 70). Chaud., Mon. 100.

There are five examples from Tenasserim, not varying much in appearance, and these, so far as I am aware, are the only specimens known. Schmidt-Goebel gives no figure, but his description is long, detailed, and accurate. The species is even smaller than *M. parreyssi* Chaud. It presents features which should render it easily recognisable. Both the smooth and polished head, and the nearly smooth prothorax are unusual in the genus, but the most striking character is the series of four polished, aeneous ridges, running longitudinally down the middle of the elytra, the two outer being both wider and shorter than the two inner ones. The suture and first stria are deeply incised, especially the latter near base; the second stria, outside the outer ridge, is also fairly wide and deep, but, the surface being dull, it is not nearly so noticeable.

71. **Brachinus (Aptinus) melancholicus** (p. 71). Chaud., Mon. des Brachynides, Ann. Soc. Ent. Belg. xix, 1876, 20.

Two examples, one of which is immature; Schmidt-Goebel did not know the locality, but both the specimens are labelled "Indien." Chaudoir quite misidentified this species, putting it into the genus *Pheropsophus*, whereas it is a true *Brachynus*; I find it to be identical with Bates' *B. caligatus* (Ann. Mus. Civ. Gen. 1889, 109, and 1892, 393) from Bhamo (*L. Fea*), a cotype of which is in my collection. Bates says: "This fine species answers with singular exactness to Schmidt-Goebel's description, as far as colours and sculpture are concerned, to his *B.* (*Aptinus*) *melancholicus*. But it differs in being furnished with wings and the elytra consequently being broad at the base and with distinct shoulders; in short it has no resemblance of form to the genus *Aptinus*."

The fault here clearly lies with Schmidt-Goebel in putting

his species under the genus *Aptinus*, which is apterous, and to which, as Bates says, it bears no resemblance. This is the more remarkable as the immature specimen has the membranous wings rather conspicuously exposed.

In the type specimen the two lines of punctures in the striae are much more evident than in the immature one, or in my example.

72. **Brachinus scitulus** (p. 72). Chaud., Mon. 59.

A single example, which the author supposed to come from Burma, and which is actually labelled "Tenasserim." Chaudoir, though with some hesitation, identified with this species an insect from Tranquebar, which he had received from Dr. Dohrn. I have not seen this, but the description of it which he gives leaves little room for doubt that the identification was incorrect. The type seems to be unique, and it is fortunately in a good state of preservation.

The description is, as usual, clear and accurate, and I will only add a few words to it. The first two joints of the antennae are flavous, the rest brown; the head is a little darker than the prothorax; the very narrow side border of the prothorax is fuscous; the elongate front spot on the elytra covers intervals 5–8, the round hind one covers 2–4. On the head between the eyes there is a pair of shallow, rounded foveae, the front and vertex are smooth and polished, the back of the head with some fine punctures and sparse pubescence.

There is in the British Museum an example labelled "Tranquebar, Ex. Mus. Murray," agreeing exactly with the description of *B. scitulus* Chaud. (not Schm.-Goeb.), and for this species I propose the new name of *B. charis*. It is larger than *B. scitulus*, 5·5 mm. against 4·0 mm., but differs little in coloration, though the scutellary region, the apical half of the epipleurae, and the border of the elytra (except near base), which in *scitulus* are dark, are in this species testaceous, and the apex of the elytra is brown. Head wider and less shiny, the antennae not quite reaching middle of elytra; prothorax relatively wider and rather more distinctly punctate; elytra evidently longer, shoulders more prominent, sides less rounded, intervals more distinctly, though still very moderately costate.

73. **Brachinus puncticollis** (p. 72). Chaud., Mon. 69; Bates, Ann. Mus. Civ. Gen. 1892, 395.

Two examples from Tenasserim differing only in the width of the red sutural stripe, a very variable character,

as Bates points out. Chaudoir did not know the species, but it was taken in some numbers by Mr. L. Fea, at Karin Asciuii Cheba, Palon in Pegu, and Kawkareet in Tenasserim; I have been able to compare a number of these examples with the typical specimens. Mr. R. Vitalis de Salvaza has also taken this species both in Tonkin and Laos; these examples are a little darker than those from Burma.

There is a long and detailed description; Bates has already compared the species with the closely allied *B. suturellus* Chaud. (Mon. 69); I may add that the elytra are darker, more shiny, and with the intervals more distinctly costate.

74. **Brachinus modestus** (p. 73). Chaud., Mon. 69; Bates, Ann. Mus. Civ. Gen. 1892, 396.

This species presents some difficulties. There are three examples all bearing the printed label Tenasserim. According to Schmidt-Goebel, the specimens which he described came from Maulmein and from the neighbourhood of Calcutta. Two of the specimens, both of which are 6·0 mm. in length, resemble each other and agree fairly with the description; I propose to restrict to them the name of *modestus*. The third example is only 5·0 mm. in length, and differs in several respects from the other two; it agrees well, however, with an example of *B. limbellus* Chaud. (Mon. 70) in my collection, already compared with Chaudoir's type. In *B. modestus* joints 3–4 of the antennae are testaceous yellow like 1–2, and the colour darkens slightly and gradually towards apex; the prothorax has a brown patch on the disk behind; the scutellary patch is narrow even at base and quickly contracts to interval 1, disappearing at middle; the apex of the elytra is dark. In *B. limbellus* joints 1–2 only of the antennae are testaceous yellow, 3–11 being of a uniform brownish yellow; the prothorax is uniformly testaceous; the scutellary patch covers four intervals on each side at base, and contracts gradually to rather beyond middle, where it disappears, the actual margin being just tinged with colour to apex; the apex of the elytra has a very distinct yellow border.

Chaudoir did not profess to know the species. Bates identified with it a number of specimens taken by Mr. L. Fea at Bhamo, Palon, and Rangoon. These are not all quite similar, but they agree in their smaller size and in

having a narrower head and prothorax. There is nothing to lead me to think that they are specifically distinct, and I propose to treat them as a minor variety.

I identify with *B. modestus* some examples in my collection from Tharrawaddy, Prome, and Taung-ngu (*G. Q. Corbett*), one in the Indian Museum taken at light in Calcutta, and one in the Fleutiaux collection from Long Xuyen in Cochin China (*Dorr*).

75. **Brachinus fusciceps** (p. 73). Chaud., Mon. 92; Bates, Ann. Mus. Civ. Gen. 1892, 397.

Another difficulty presents itself here. There are three specimens, but only one of them, labelled "Burma, Helfer," is indicated as type, the other two being without locality label. The supposed type, however, does not agree with the description, and, although so decrepit an affair that I cannot identify it with certainty, I think it is another example of the previous species *B. modestus*. The other two examples agree with the description, and I look upon them as typical.

Chaudoir perceived that this and some other species differed in important characters from *Brachynus*, and he proposed for them a new genus *Styphlomerus* (Mon. 87). He did not know Schmidt-Goebel's species, but thought it quite possible that it would prove to be identical with Boheman's *Brachynus bicolor* (Eug. Res. Zool. Col. 1861, 3) from Hong-Kong, to which Gemminger and Harold gave the new name of *B. dichrous*. Bates shared this opinion, and, after comparing examples from Hong-Kong and Burma, I have come to the conclusion that the species are the same, though I have not seen Boheman's type.

The description is not a long one, but the species seems to be fairly well known. It was taken in some numbers by Mr. L. Fea at Shwegoo and Karin Cheba; I have seen three of these specimens from the Genoa Museum, varying greatly in size (5·0–7·0 mm.), as mentioned by Bates. I have also three Burmese specimens in my own collection from Tharrawaddy and Prome (*G. Q. Corbett*).

76. **Brachinus marginalis** (p. 74) (1921, 149).

A single example from Tenasserim, belonging to the genus *Pheropsophus*. Schmidt-Goebel, like Chaudoir, identified the species quite erroneously with Dejean's *P. marginalis*. I have quite recently referred to this species, and will not repeat what I said. I think it should bear the name *P. nebulosus* Chaud.

77. **Brachinus interruptus** (p. 74).

Two examples of the genus *Pheropsophus*, both labelled "Tenasserim." The author identified them with *P. interruptus* Dej. (Spec. Gen. i, 1825, 306), which Chaudoir (Mon. 37) considered a variety of the same author's *P. fuscicollis* (p. 306). I do not remember seeing the type of the former in Mr. René Oberthür's collection, but I have no reason to doubt the correctness of Chaudoir's opinion, especially as it fits in well with the original description. The two Helfer specimens, on the other hand, do not agree with it, but they do agree with an example of *P. agnatus* Chaud. (Mon. 43), which I compared at Rennes with the type, and I consider that they belong to that species. I think Dejean's *P. javanus* (p. 305), and Chaudoir's variety *P. fimbriatus* (Mon. 42) are identical, the markings on the upper surface being subject to great variation.

The species is widely spread in S.E. Asia, but I have seen only two examples from India; these are in the Indian Museum, and came from Balighai in Orissa (*Dr. N. Annandale.*).

78. **Brachinus consularis** (p. 75). Chaud., Mon. 41; Bates, Compt. rend. Soc. Ent. Belg. 1891, 336; *id.* Ann. Mus. Civ. Gen. 1892, 392.

Three examples of a *Pheropsophus* from Tenasserim. Chaudoir evidently thought that his *P. stenoderus* (Bull. Mosc. 1850, i, 77 and Mon. 41) would prove to be the same species as *P. consularis*, and Bates used Schmidt-Goebel's name in preference to Chaudoir's. There can be no doubt about this identification, for an example already compared with Chaudoir's type agrees almost exactly with the specimens from Tenasserim. The markings both of the upper and under surfaces are the same, and the only differences I note are in the colour of joints 3–4 of the antennae, which is generally fuscous in North Indian examples, but more or less testaceous in the typical specimens, and in the narrower elytral costae of the latter.

There are five examples in the Genoa Museum, taken by Mr. L. Fea at Bhamo, Karin Cheba, and Palon. One of these differs rather widely from the others; the antennae are very light in colour, the knees black above as well as at the sides, and the elytral fascia not only double the usual width, but also placed far back on the elytra. Bates labelled this "? Consularis var. aut nov. sp.?"

Other localities are Tetara and Konbir in Chota Nagpur (*Père Cardon*), Silonibari (*H. Stevens*) and Sibsagar in Assam, and Chapra (*Mackenzie*), Sarda (*F. W. Champion*), Dacca, and Siliguri in Bengal.

79. **Mochtherus angulatus** (p. 76).

Five examples and two others indicated as "cotypes." I have already published notes on this much-described species (1919, 163), which should be known as *M. tetraspilotus* Macl., and have nothing further to add.

80. **Mochtherus rotundatus** (p. 77). Chaud., Mémoire sur les Coptodérides, Ann. Soc. Ent. Belg. xii, 1869, 241 and 246; Bates, Ann. Mus. Civ. Gen. 1889, 111, and 1892, 413.

Both Chaudoir and Bates recognised that this species would have to go into Schmidt-Goebel's own genus *Dolichoctis*, a circumstance which the author curiously enough overlooked, but whereas Bates identified it, Chaudoir did not do so. The species is very near *D. striata* Schm. Goeb., and I think Chaudoir's 4-spotted varieties of the latter (Memoir, p. 248) belong to it; his *D. tetrastigma* also (p. 248) appears to differ only in the form of the prothorax. The shape of this is very variable, as Bates has already pointed out; this variability is very marked in the three typical examples, in two of which the prothorax is wide, with sides hardly sinuate before the hind angles, whereas in the third it is relatively narrow, with distinctly sinuate sides. Bates also tells us that his *D. ornatellus* from Japan (Trans. Ent. Soc. Lond. 1883, 282) is synonymous with *rotundatus*, nor have I been able to find any substantial characters to differentiate his *D. fasciola* (Ann. Mag. Nat. Hist. (5), xvii, 1886, 205), taken by Mr. George Lewis in Ceylon, from Schmidt-Goebel's species.

The author is quite incorrect in stating that the setiferous pores on the sides of the prothorax are wanting in this species; they are, on the contrary, quite evident, but just within the border, so that they do not affect in any way the continuity of outline. No mention is made of any pores on interval 3, of which—as in *M. angulatus*—there are two, one rather behind middle and the other at about a fifth from apex on the hind yellow spot. In *M. angulatus* these pores are large and adjoin stria 2, but in *rotundatus* they are minute and placed on the middle of the interval.

The species is widely distributed over S.E. Asia, but I

have seen only one example from India; this is in the Indian Museum, and came from Cochin State, Parambikalam (*F. H. Gravely*).

81. **Celaenephes parallelus** (p. 78, Tab. II, fig. 5). Bates, Ann. Mag. Nat. Hist. (5), xvii, 1886, 211; *id.* Ann. Soc. Ent. Fr. 1889, 286; *id.* Ann. Mus. Civ. Gen. 1892, 420; Bouchard, Ann. Soc. Ent. Fr. 1903, 176; Lesne, Mission Pavie Hist. Nat. 1904, 80; Vuillet, Insecta, ii, 1912, 17; Andr., Trans. Ent. Soc. Lond. 1919, 188; Sloane, Proc. Linn. Soc. N.S.W. 1920, 322.

There are four examples in the collection. The figure is excellent, but of the three well-marked pores on interval 3, only the front one is shown; the pore which appears on interval 6, towards apex, has no existence in fact. I published some notes recently on this species, as quoted above, but give a number of references here, which I omitted before. These indicate that the species is well known and widely distributed.

82. **Thyreopterus ater** Cast., Études Entom. 1835, 149 (p. 79). Chaud., Mémoire sur les Thyréoptérides, Ann. Soc. Ent. Belg. xii, 1869, 136; Bates, Ann. Soc. Ent. Fr. 1889, 283; *id.* Ann. Mus. Civ. Gen. 1889, 110, and 1892, 408.

Chaudoir made for this and for a species from Madagascar the genus *Peripristus*. There are in the Eastern species three pores on interval 3, two near together on the apical third, the third quite close to apex. It is common throughout S.E. Asia, but does not, so far as I know, occur in China or Japan. The collection contains three examples, the locality of which was unknown.

83. **Thyreopterus impressus** (p. 80). Chaud., Mémoire sur les Thyréoptérides, Ann. Soc. Ent. Belg. xii, 1869, 142; Bates, Ann. Mus. Civ. Gen. 1892, 406; Andr., Ann. Mag. Nat. Hist. (9), iii, 1919, 483.

Chaudoir did not apparently know this species and made no attempt to incorporate it in his Memoir. Bates, however, recognised it among the Carabidae taken by Mr. L. Fea in Burma, but he adds: "the species has not the facies of those which constitute the restricted genus *Thyreopterus* in Chaudoir's Monograph." I recently proposed for it the new genus *Sfitakantha*, in the description of which there is an error to be corrected. I stated that there was a single pore on interval 3, whereas there are actually three, the two discal ones very minute, at about the middle and at a

fourth or a fifth from apex; the apical pore is rather larger and is situated on the short ridge close to apex, formed by the junction of the third and fifth intervals. Bates has already drawn attention to some points not fully brought out in the original description.

Two examples from India or Burma. I have seen specimens from Burma (*L. Fea*); Assam, Sudiya (*Doherty*); Penang (*G. E. Bryant*); Perak (*Doherty*); Java; Sarawak (*Wallace*); and various localities in Laos (*R. Vitalis de Salvaza*).

84. **Catascopus facialis** Wied., Zool. Mag. i, 3, 1819, 165 (p. 81).

References to this species are numerous, and I have already published several notes on it (1919, 130 and 141; 1921, 165). There are four specimens in the collection, three from Tenasserim (*Helfer*), and one from Java (*Hofmann*), the last evidently added at a later date. The Helfer specimens all have intervals 8–9 metallic green, and in one of them the base is also green, but in no other way do they differ from typical Indian examples of Wiedemann's species.

Schmidt-Goebel, who has a long note on the various species of *Catascopus* described at that time, draws attention to the reigning confusion regarding *C. facialis*, which unfortunately he himself increased by underestimating the size of his specimens. Chaudoir fixed on this (Bull. Mosc. 1850, ii, 352) and expressed the opinion that Schmidt-Goebel's species differed from Wiedemann's. When Gemminger and Harold in 1868 published the first volume of their Catalogus Coleopterorum, they seem to have assumed, without further investigation, the correctness of Chaudoir's hypothesis, and gave the species the new name of *C. goebeli*. A little later Chaudoir (Rev. et Mag. Zool. 1872, 245) appropriated this name, describing two specimens of his own from Malacca, and remarking: " C'est peut-être le *facialis* Schmidt-Goebel, dont il a la taille, et dont la description lui convient à peu pres." In the next paragraph he describes under the name " var. ? *basalis* " another insect from Cambodia, and his *goebeli* must take this name, if indeed it belongs to the same species. Thanks to Mr. René Oberthür I have had the opportunity of seeing both Chaudoir's types, and I incline to think they may both prove to be forms of Wiedemann's *C. facialis*; without further investigation, however, I do not feel able to express

a definite opinion about this. What is quite clear to me is that Schmidt-Goebel's *facialis* is the same as Wiedemann's.

85. **Catascopus violaceus** (p. 82). Chaud., Berl. Ent. Zeitschr. 1861, 122; Bates, Ann. Mus. Civ. Gen. 1892, 410.

Chaudoir redescribed this species under the name of *C. cyanipennis* (Bull. Mosc. 1854, i, 130); he discovered subsequently that the two species were nearly related, but did not succeed in identifying them. I have had the opportunity of comparing the same specimen with both types. The colour of the elytra varies a little, and in Burmese specimens the disk is often very dark, in fact almost black. There are four typical examples from Maulmain, all very much alike.

The species seems fairly common, but is apparently confined to Assam, Sikkim, Bengal, Burma, and the Malay Peninsula. There is an example in the Brussels Museum labelled Borneo, probably in error.

86. **Catascopus elegans** Weber, Obs. Ent. 1801, 45; Fab., Syst. Eleuth. i, 1801, 184 (p. 83).

There are five similar specimens in the collection from Maulmain. This is another common species, to which references by other authors are numerous. I have not seen Weber's type, but I have compared specimens with the type of Fabricius, described in the same year, but apparently a few months later.

The *C. elegans* of Macleay (Ann. jav. 1825, 15) is quite another species (1919, 141). Bates gave the name var. *scintillans* to specimens taken in Burma by Mr. L. Fea, which he identified with those described by Schmidt-Goebel. It is true that the striae of the elytra are deeper and rather more coarsely punctured at the base than in examples from the Malay region, but there is much variability both in this respect and in coloration, so that I consider Bates' name superfluous.

The species is very common in the Malay region and extends southwards to Australia. I have seen Indian specimens from Bengal, Sikkim, and Assam only. It ranges eastwards through Siam and Indo-China to the Philippine Is., but does not seem to occur in China or Japan.

87. **Catascopus elevatus** (p. 84).

A unique specimen. Chaudoir expressed the tentative opinion (Berl. Ent. Zeitschr. 1861, 122) that the species was nearly allied to his *C. amoenus* (= *elegans* Weber), but I can find no other reference to it. The elytra are strongly

costate, but I can detect no other character to differentiate this specimen from *C. elegans*, of which I consider it to be a malformation.

88. **Catascopus pauper** (p. 84).

Another solitary type, and once again Chaudoir is the only commentator, his view being that Schmidt-Goebel's example was probably a faded specimen of *C. smaragdulus* Dej. I have in my collection an example of this species, already compared with Dejean's type, and on a comparison of the two insects I find that Chaudoir's hypothesis is perfectly correct.

My records indicate that the species is found in Bengal, Burma, Perak (*Doherty*), Penang (*Lamb*), Hoabinh in Tonkin (*R. Vitalis de Salvaza*), and Java (*Coll. Sloane*).

89. **Catascopus regalis** (p. 84). Chaud., Berl. Ent. Zeitschr. 1861, 122; Bates, Ann. Mus. Civ. Gen. 1892, 410.

Two examples. This well-marked species was unknown to Chaudoir, but Bates records its capture in Burma by Mr. Fea, and I have found it to be widely distributed in collections of Carabidae. The description is excellent. The three pores on the carinate third interval are placed, the first at a sixth from base, the second at a third from apex, and the third very near apex. The prosternal process and metasternum are covered with a short dark rufous pubescence.

The species is found in Assam (*H. Stevens* and *W. F. Badgley*), Sikkim (*H. Stevens*), Burma (*Helfer*, *L. Fea*, and *S. E. Peal*), Andaman Is. (*Atkinson*), Nicobar Is. (*Roepstorff*), and Tonkin and Laos (*R. Vitalis de Salvaza*).

90. **Pericallus ornatus** (p. 86). Bates, Ann. Mus. Civ. Gen. 1892, 411; Dupuis, Ann. Soc. Ent. Belg. 1913, 83.

Four examples, varying a little in size, but otherwise similar: on only one of them is there a small yellow spot behind on interval 4, alongside that on interval 5. The description is good, but as regards the elytral pattern hardly detailed enough. The round yellow spot in front covers intervals 4–7. Of the three small yellow spots behind, the intermediate one on interval 5 (and sometimes 4) is a good deal in advance of the other two; the inner spot is on intervals 2–3, the outer one on 7. The author only mentions two pores on interval 3, but there are really three, viz. first near base, second just behind middle, and third at extreme apex of interval. The size varies from 9·0 to 12·0 mm.

I have seen specimens from Assam and Sikkim (*H. Stevens*), Garo Hills (*S. W. Kemp*), Burma (*Doherty* and *L. Fea*), North Shan States (*J. C. Brown*), Renong in Siam (*Doherty*), Cambodia (*Mouhot*), and Laos (*R. Vitalis de Salvaza*).

91. **Masoreus sericans** (p. 87). Schaum, Berl. Ent. Zeitschr. 1863, 78; Chaud., Étude monographique des Masoréides, etc., Bull. Mosc. 1876, iii, 28.

Schaum did not know the species, but Chaudoir had seen Schmidt-Goebel's type at Prague. He expressed the opinion that it was not a *Masoreus*, but should come near the genus *Mochtherus*. I think it should certainly be placed among the Coptoderini, but I know of no genus into which it will fit. I am reluctant to propose a new genus for a single imperfect specimen, which I am not at liberty to dissect, but, as the species has been described, I see no alternative, and propose to give the best account of it I can, leaving any blanks to be filled in when additional material becomes available.

MOCHTHEROIDES, gen. nov.

Head with two supraorbital setae, eyes contiguous to buccal fissure, gula with a seta on each side, labrum as long as wide, sexsetose, rounded in front; ligula bisetose, arcuate at extremity, paraglossae membranous, adnate, rounded at apex, meeting above and extending beyond ligula, curving inwards; mentum emarginate, the emargination dilated at middle into a rounded prominence, hardly a tooth, lobes rounded at sides, epilobes rounded at apex, hardly reaching beyond lobes; palpi cylindrical, subtruncate at apex, maxillaries with joint 4 nearly twice as long as 3, 2 much dilated, labials with 2 a little shorter than 3; antennae with joint 2 a little shorter than 3, setose from apical third of joint 4. *Prothorax* transverse, with two setiferous pores on each side. *Elytra* in form of a rectangle, with rounded angles, some very long setae at shoulders. *Legs*: hind femora dilated, tibiae channelled on outer side, terminal spurs minute, tarsi more or less pubescent above, protarsi ♂ with 3 dilated joints clothed beneath with large white scales, claws with two or three small equal teeth on each half.

In *Mochtherus*, which the genus resembles in many ways, the ligula is plurisetose and the paraglossae do not extend beyond it, the palpi are more pointed at apex, and the teeth on the claws are not only longer, but of unequal size.

Mochtheroides sericans Schm.-Goeb.

Length: 5·0 mm. Width: 2·0 mm.

Colour black, underside piceous: antennae, buccal organs, tibiae and tarsi testaceous. Head and prothorax finely, elytra coarsely shagreened and sericeous.

Head convex, smooth, clypeus bisetose, the suture fine, ending on each side in a fine puncture, eyes not very prominent, antennae reaching basal third of elytra. *Prothorax* moderately convex, not much wider than head, half as wide again as long, widest at apical third, base slightly produced in middle and a little oblique at sides, apex emarginate, sides finely bordered, rounded in front, with a rather faint angle at apical third, where the front seta is situated, just inside the border, then contracted and nearly straight to the obtuse hind angles, which are reflexed, with a very distinct tubercle (setae abraded); median line and transverse impressions all fairly deep, surface smooth. *Elytra* moderately convex, half as long again as wide, a little more than half as wide again as prothorax, the fine border very distinct at base, shoulders square, apex truncate but hardly emarginate, striae fine and very finely punctate, intervals slightly convex, 3 (apparently) with a single pore near apex, surface with some very fine scattered punctures.

Smaller than *Mochtherus tetraspilotus* Macl., and without spots. Head smoother, impunctate, eyes much smaller and less prominent; prothorax wider, with much narrower reflexed border, which is hardly sinuate behind, front angles more evident, hind angles obtuse and less reflexed, surface smoother; elytra with rather more convex intervals, the surface more coarsely shagreened and distinctly sericeous.

A single example (♂) from Tenasserim.

92. **Aephnidius adelioides** Macl., Ann. jav. 1825, 23, t. 1, f. 7 (p. 88) (1919, 159).

Two specimens, one labelled "Burma," the other "Tenasserim," and both agreeing well with Macleay's type, upon which I have recently commented.

93. **Aephnidius fuscipennis** (p. 89). Schaum, Berl. Ent. Zeitschr. 1863, 78; Chaud., Mon. 16; Bates, Ann. Mus. Civ. Gen. 1889, 110, and 1892, 404.

One example from Tenasserim. Chaudoir's specimen came from Dacca. Mr. L. Fea took it in some numbers at Bhamo, Shwegoo, and Kawkareet. In the British Museum there are examples from Tavoy (*Doherty*), Penang, and Siam. Mr. Vitalis de Salvaza has taken it at Kompong

Kedey in Cambodia, and there is also a specimen from Cambodia in the Brussels Museum. In the Indian Museum there is an example from the rather outlying locality of Rawalpindi in the Punjab (*R. Hodgart*).

The description is not very long, but it is accurate and has been supplemented by Chaudoir. The type is evidently a little immature, for all the other examples I have seen are black, with only a very narrow dark red border to the prothorax and elytra; the latter are also exceptionally opaque. In this species the various pores on the upper surface are very conspicuous, viz. two supraorbital, two on each side of prothorax, one rather before middle and one on the hind angle, one on each side at base of elytra, from which arise striae 1 and 2, two on interval 3, adjoining stria 3, at about a third and two-thirds respectively, and a marginal series on interval 9.

94. **Aephnidius simplex** (p. 89). Schaum, Berl. Ent. Zeitschr. 1863, 78; Chaud., Mon. 22; Bates, Ann. Mus. Civ. Gen. 1889, 110, and 1892, 405.

Another single specimen from Tenasserim. In this case also the rather short description has been amplified by Chaudoir, and as the species seems to be well known I will not enlarge further upon it. It occurs throughout Burma and in the Andaman Is., and in India from Nepal to Ceylon, but I have at present seen no examples from outside these limits.

95. **Aephnidius fasciatus** (p. 89). Schaum, Berl. Ent. Zeitschr. 1863, 78; Chaud., Mon. 25; Bates, Ann. Mus. Civ. Gen. 1892, 405 (1919, 159).

There are five similar examples from Tenasserim, and Chaudoir had another one coming from the same source in his collection. The species falls within Macleay's genus *Anaulacus* (Ann. jav. 1825, 22), and I have already compared with it Macleay's closely allied *A. sericipennis*. The description is long and excellent; but the base of the prothorax is widely arcuate rather than truncate, and its margin bisinuate on each side of the scutellum, at which points it is distinctly bordered. There are three (sometimes four) very distinct setiferous pores on each side of the prothorax in front and another on the hind angle, one on each side of scutellum at the base of the elytra, and a series of large marginal pores, but I can detect none on interval 3.

The species seems to be fairly widely spread, for I have

seen examples from the following localities: Karin Ghecu in Burma (*L. Fea*), Andaman Is. and Ceylon (British Museum), Kanara (*T. R. D. Bell*), Nilgiri Hills (*H. L. Andrewes*), Bon Som in Indo-China (*R. Vitalis de Salvaza*). Mr. Andrewes took his specimens in the Ouchterlony Valley at 3000–3500 feet "in heavy jungle in dead tree trunks."

I have been able to compare with Schmidt-Goebel's specimens the type of *Masoreus* (*Anaulacus*) *basalis* Fleut. from Annam. The author himself subsequently recognised that his species was a variety of *A. fasciatus*, differing only in the absence of the apical testaceous patch.

In redescribing *Anaulacus sericipennis* Macl. (1919, 158) I said that there was only one supra-orbital pore. This is an error which I desire to correct, for there are in reality two such pores.

96. **Aephnidius quadrimaculatus** (p. 90, Tab. III, fig. 7). Schaum, Berl. Ent. Zeitschr. 1863, 78; Chaudoir, Mon. 25; Bates, Ann. Mus. Civ. Gen. 1892, 405.

One example from Tenasserim. The only other specimen I have seen is the one taken by Mr. L. Fea at Karin Cheba, which agrees well with the type. Chaudoir, who did not know the species, thought it possible that it was identical with the previous one, *A. fasciatus*, but, as Bates points out, this is far from being the case. The description is short, but has been amplified by Bates. The figure gives a fair idea of the insect, but the elytra are rather too pointed at apex, and the red spot on the shoulder should be rather larger. In the Karin Cheba example the whole of the apical area is red. In this species there are only two marginal setiferous pores on each side of the prothorax, one before middle and one on the hind angle; the elytra are strongly depressed on each side of the scutellum, with an umbilicate pore at the bottom of the depression, interval 3 impunctate.

97. **Caphora humilis** (p. 91, Tab. III, fig. 8). Chaud., Mon. 8.

I have seen fifteen examples of this species in the collection, all from Tenasserim, but only two of them bear "type" labels. Chaudoir did not concern himself much with this genus or species, but tells us that he has in his collection examples from Bengal.

The genus differs from *Masoreus* and *Aephnidius* in having a tooth in the sinus of the mentum; the species is unique in the genus, and is much smaller than either

A. fasciatus or *quadrimaculatus*. In the figure the elytra are represented as brown instead of black, and the line beside it is about half as long again as it ought to be. The clypeus is bisetose, and there are on each side of the head two supra-orbital setae; the prothorax has two setiferous pores on each side, one before middle and one on the hind angle; there is an umbilicate pore at the bottom of a depression on each side of the scutellum, and a marginal series of similar pores, but none on interval 3.

There are two examples in the British Museum, labelled "Siam" and "E. Indies" respectively, and one in the Indian Museum from Kierpur, Purneah District, Bengal (*C. Paiva*).

98. **Tetragonoderus punctatus** (p. 92).

Schmidt-Goebel mentions no locality, but the single specimen bears the Museum label Tenasserim. He considered that it was the *T. punctatus* of Wiedemann (Zool. Mag. ii, 1, 1823, 61) and of Dejean (Spec. Gen. iv, 1829, 505), but added some particulars in which it seemed to him to differ from the description given by the latter author. I have in my collection a specimen which I compared at Copenhagen with Wiedemann's type, and the example under consideration does not agree with it; not only are there discrepancies in the elytral pattern, but the form and surface of the prothorax differ. In the prothorax it agrees well with *T. fimbriatus* Bates (Ann. Mag. Nat. Hist. (5), xvii, 1886, 202), and as far as the pattern of the elytra goes it might pass for a rather washed-out example of that species. Although not satisfied of its identity with *fimbriatus*, I propose to treat it as a variety, until further material is available. The species is known at present from South India and Ceylon only.

In the Helfer specimen, the central brown fascia is very wide and the black border surrounding its central part is very slight; at the sides this border is well developed, but the brown colour there forms a separate patch; the central and front brown areas are joined along intervals 1–2, both of which are uniformly brown, the usual black and white chequers on 2 being barely indicated.

99. **Tetragonoderus rhombophorus** (p. 93). Chaud., Mon. 48; Bates, Ann. Mus. Civ. Gen. 1892, 415.

There are two specimens in the collection, both from Tenasserim. Unknown to Chaudoir, but taken by Mr. L. Fea at Rangoon, Palon, and Bhamo: I have two other

Burmese examples in my collection taken at Tharrawaddy (*G. Q. Corbett*), and there is one from Upper Tenasserim (*J. Wood Mason*) in the Indian Museum. I have also seen examples from "India" (British Museum) and Sarda in Bengal (*F. W. Champion*), while Mr. R. Vitalis de Salvaza has taken the species at Xieng Khouang and Vientiane in Laos, so that it is fairly widely spread.

Chaudoir was quite correct in the position he assigned to this species in his table, *i. e.* "Tarsi intermedii maris articulis tribus angustius dilatatis subtusque spongiosis, prosternum inter coxas marginatum, anus maris integer (haud incisus), unguiculi basi vix perspicue denticulati." There are in this species two prothoracic setae on each side, both within the border, the front one rather before middle, the hind one at the hind angle; there is a small umbilicate pore on each side of the scutellum, and a marginal series of few but large pores, from some of which issue very long hairs; on interval 3 are two pores, one rather before middle adjoining stria 3, the other at apical third adjoining stria 2. It will easily be recognised by the broad red-brown stripe on the prothorax and the rhomboidal patch of similar colour on the elytra; in shape it is like *T. quadrinotatus* F. and *T. quadrisignatus* Quens.

100. **Scarites selene** (p. 94). Chaud., Bull. Mosc. 1855, i, 108; *id.* Mon. des Scaritides (ii), Ann. Soc. Ent. Belg. 1880, 95; Bates, Ann. Mus. Civ. Gen. 1892, 273.

There are three specimens from Tenasserim, all bearing "type" labels. Of these two conform to the description, as far as it goes, and both measure 27·0 mm. in length; these I regard as truly typical. The third example, measuring 31·0 mm., is evidently different and I identify it with *S. barbarus* Dej. (Spec. Gen. i, 1825, 388), of which I have in my collection an example compared with Dejean's type.

Chaudoir was evidently aware that his *S. capito* (Bull. Mosc. 1855, i, 92; *id.* Mon. (ii), 95) was the same thing as Schmidt-Goebel's species, but he declined to recognise the latter on the ground that the description was incomplete. It is true that the German description breaks off short, but the Latin diagnosis at the head is complete and Schmidt-Goebel's name must stand. The species is a well-known one, and has been dealt with at considerable length by Chaudoir. I have seen numerous examples from Burma, Bengal, and Assam; also a single specimen

from as far west as Lucknow. An example in the British Museum is labelled "Madras," and I have seen another taken by Dr. W. Horn at Anuradhapura in Ceylon.

THE PLATES.

My notes on the species described in the Faunula would be incomplete without some reference to the three plates at the end of the volume. With these the author was not at all satisfied, and indeed he proposed to replace the first (uncoloured) by another one, when the next part was published, an event which never occurred. A glance at the plates gives the impression that the numerous outline drawings, especially those of the buccal organs, were made from dissections, but of these I have seen no trace, and, as some of the examples figured were unique, the drawings must have been made from an examination *in situ*. It is not my intention, however, to go into the generic characters as revealed by the plates, as practically all the genera have been dealt with subsequently by other authors, but to indicate what species are represented by such figures as are not alluded to in the text. On the back of the green paper cover is a list of the figures referred to; the species are named, but there is no further account of them, and to the number must be added Plate I, fig. 9, and Plate II, fig. 7. All the figures in Plate I, with the exception of fig. 9, represent species of the genus *Cicindela*, and for convenience of reference I have added the names of the two species not expressly mentioned in the text, though both are vaguely referred to at the end of the respective descriptions. There is no indication in the collection of the actual specimen figured in any single instance, and sometimes I have not been able to find any representative at all of the species which I identify with the figure.

Plate I.

Fig. 2. **Cicindela striolata** Illiger, Wiedemann's Archiv. I (2), 114 (p. 3).

Fig. 5. **Cicindela phalangioides** (p. 8).

Fig. 9. ?**Arame graciliceps** Bates, Ann. Mus. Civ. Gen. 1892, 381 (see under No. 6, *Odacantha litura*).

Plate II.

Fig. 4. **Libresthis truncata** *in litt.* (1921, 183).

I find two specimens from Tenasserim labelled "*Libresthis fusca*," so that the author apparently changed his specific name; the specimens are not quite alike, but one of them agrees very closely with the examples taken by Mr. L. Fea and erroneously determined by Bates as *Pogonoglossus validicornis* Chaud. I have recently described the species under the name of *P. truncatus*. The figure is a fair representation of it, but joint 1 of the antennae is too short and thin, and the mandibles should be longer.

Fig. 6. **Holconotus ferrugineus** *in litt.* Chaud., Bull. Mosc. 1869, ii, 399; Bates, Ann. Mus. Civ. Gen. 1892, 364; Tchitcherin, Note sur le genre *Holconotus*, Ann. Soc. Ent. Belg. 1898, 453.

Numerous examples from Tenasserim. Chaudoir first described the species under the genus *Abacetus*, but rectified this error subsequently (Rev. et Mag. Zool. 1876, 352), though before the genus came to be described the name of *Holconotus* was already occupied, so that Maindron's name of *Fouquetius* (Bull. Soc. Ent. Fr. 1906, 252) must be used. The figure is fairly good, but the colour is a little too light, the eyes too prominent, the antennae too slight, joint 1 of the tarsi much too short, and there is no suggestion of the dentate border of the elytra behind the shoulder.

Fig. 7. **Dicranoncus amabilis** Chaud., Ann. Soc. Ent. Fr. 1859, 350 (note) and 359; *id.* Révision des Colpodes, Ann. Soc. Ent. Fr. 1878, 277 (1919, 164).

I have come across no attempt to identify this figure, but I find in the Helfer collection some examples from Tenasserim, which agree fairly well with it, and I have seen numerous similar specimens from various localities in the East. The outline drawing of the claws indicates the genus *Dicranoncus* sufficiently, and with black knees (which, considering the admitted imperfection of the plates, may very possibly have been omitted by accident) the figure would be a fair representation of *D. amabilis*. The prothorax in the figure is a little too much contracted behind. This species occurs all over S.E. Asia, including the Malay Archipelago, but does not apparently extend to China or Japan.

Fig. 8. **Batoscelis polita** *in litt.* Bates, Ann. Mus. Civ. Gen. 1892, 343 (1921, 162).

Bates has already pointed out that this figure probably represents *Pachytrachelus oblongus* Dej. (Spec. Gen. v, 1831, 813), and I agree with him. Though quite recognisable, it does not show the usual fuscous patch on the disk of the elytra, but the colour in this species is very variable. The sketch of the front tibia makes too much of the two groups of spines (two in each) on the external margin, each one being in fact nearly equidistant from the next, the two apical ones a little closer together, and a distinct emargination between two and three. The eyes also are not sufficiently prominent, and joint 1 of the antennae is much too small. I have referred to Dejean's species quite recently, as quoted above.

Plate III.

Fig. 2. **Agreuter melas** *in litt.* Bates, Ann. Soc. Ent. Fr. 1889, 268; *id.* Ann. Mus. Civ. Gen. 1889, 103.

Bates identified this figure with his *Oxycentrus angustus* (Trans. Ent. Soc. Lond. 1876, 3 (note)), with which it agrees extremely well. The drawing of the labrum, however, shows that organ as quadrisetose, instead of sexsetose, and there is actually no minute emargination in the front of the clypeus. I have not been able to find in the Helfer collection any example of this species, which is found throughout Burma, the Malay Peninsula, Siam, and Indo-China; Bouchard also records it from Sumatra (Ann. Soc. Ent. Fr. 1903, 172).

Fig. 4. **Eupalamus clivinoides** *in litt.* Putzeys, Révision Générale des Clivinides, Ann. Soc. Ent. Belg. x, 1867, 130; Bates, Ann. Mus. Civ. Gen. 1889, 100 (1919, 179).

There are in the collection a number of specimens from Tenasserim. Putzeys first pointed out that Schmidt-Goebel's genus did not differ in any essential character from *Clivina*, and he identified the species, quite rightly I think, with his *C. Parryi* (Postscr. ad. Cliv. Mon., Mém. Liège, xviii, 1863, 60; *id.* Rév. Gén. 130). I have already mentioned that this is the same thing as *C. castanea* Westw. (Proc. Zool. Soc. 1837, 128). The figure is rather a good one as far as general appearance goes, but no details are shown of the surface of the head, and the colour should be quite black. The species is common throughout the East.

Fig. 4. **Indalmus elegans** *in litt.*

I can trace no reference to this species, but there are two

examples in the collection, appearing under the name of *Chlaenius elegans* Helfer, and these I have no hesitation in identifying with *C. Camillae* Gestro (Ann. Mus. Civ. Gen. 1888, 108). The generic name appears to be superfluous. The figure, without being good, is approximately like the insect, though the front angles of the prothorax are too much rounded off. Helfer's specimens come from Tenasserim, those taken by Mr. L. Fea and described by Dr. R. Gestro from Teinzo, and I have seen other examples from Laos, Annam, and Cambodia (*R. Vitalis de Salvaza*).

Fig. 6. **Phreoryctes pusillus** *in litt.* Putzeys, Révision Générale de Clivinides, Ann. Soc. Ent. Belg. x, 1867, 97; *id.* Compt. rend. Soc. Ent. Belg. 1878, 174; Bouchard, Ann. Soc. Ent. Fr. 1903, 170.

In his Révision Générale Putzeys writes : " M. Schmidt-Goebel s'était proposé d'établir sous le nom de *Phreoryctes* un genre dont il a figuré les caractères dans la pl. III, (fig. 6) de sa Faun. Birman. Mais d'après une note de sa main inscrite sur la couverture de la première livraison de l'ouvrage, il a reconnu que ce genre ne se distinguerait pas suffisamment des *Dyschirius* et il a désigné sous le nom de *Dyschirius debilis* l'insecte figuré comme *Phreoryctes pusillus*."

A little lower on the same page Putzeys described a new species from North India, *Dyschirius interpunctatus*, which he later identified with Schmidt-Goebel's. I can find in the Helfer collection no example of the genus *Dyschirius*, nor have I seen the type of *D. interpunctatus*, though there is in the British Museum a single example from Ferozepur which I identify with it. Putzeys does not say that he had seen Schmidt-Goebel's type, nor does he tell us on what his identification was founded. The figure is evidently very much lighter in colour (though this may be due to a defect in the plate), and does not show any series of pores on intervals 3 and 5. I think, therefore, that Putzeys is probably wrong, but there appear to be no means of deciding this at present, or determining the species. I have no idea how Bouchard arrived at his determination.

Fig. 9. **Loxoncus elevatus** *in litt.* Chaudoir, Bull. Mosc. 1852, i, 90; Lacordaire, Gen. Col. i, 1854, 304 (note); Motchulsky, Bull. Mosc. 1864, iii, 204; Bates, Ann. Mus. Civ. Gen. 1892, 347.

The first three of the authors quoted above refer to Schmidt-Goebel's genus, which was described by Chaudoir

under the name of *Anoplogenius*. Bates refers to the species, but was unable to identify it owing to "the peculiar one-sided lobe of the hind tarsi so conspicuously figured." I cannot discover the figured specimen, but there are examples of three different species of the genus, which I have examined for the asymmetrically bilobed fourth joint of the hind tarsi shown on the plate. This I have not found, nor do the other described species, so far as I know them, present such a character. Apart from this and the apparent depression on the disk of the elytra, the figure may be taken as offering a reasonable representation of *A. renitens* Bates (Ann. Mag. Nat. Hist. (5), xvii, 1886, 79), which was described from Ceylon, but occurs also in Burma. It is quite possible, and I think even probable, that there is here another defect in the plate, but Bates may also be right in suggesting that Schmidt-Goebel's "species must therefore be one that remains to be rediscovered."

INDEX.

II. *A Revision of the Australian Species of the genus* Melobasis (*Fam.* Buprestidae, *Order* Coleoptera), *with Notes on Allied Genera.* By H. J. Carter, B.A., F.E.S.

[Read November 15th, 1922.]

Plates I, II.

Introduction.

The number and variety of Buprestidae in Australia, combined with their brilliant metallic coloration, makes their study peculiarly attractive. This has been so generally the case that collectors of many nations have, during the last century, supplied the museums of the world with specimens that have been described by various authors with but little co-ordination. I have already attempted to clear up the nomenclature of the genus *Stigmodera*; but there yet remain, if possible, in still greater confusion the two important genera *Melobasis* and *Cisseis*, together with a few allied genera. It is hoped that the following paper will help the student to a clearer knowledge of the former group, and especially clear the ground of a mystifying maze of names by banishing into oblivion that blight on Entomology—unnecessary synonyms.

Revision of the Australian species of the genus *Melobasis* Castelnau et Gory (Fam. *Buprestidae*, Order *Coleoptera*).

The insects comprised in the genus *Melobasis* appear to be confined to Australia, Malaysia and Polynesia, one species being described from as far west as Penang. The present memoir will refer only to the Australian members which include 80 per cent. of the group.

In Australia they occur chiefly on the foliage of the numerous species of Acacia—perhaps the most ubiquitous members of the Australian flora—though a few appear to specialise on other plants in the stems of which their larvae exist. Thus, in the Sydney district, I have found *M. cupriceps* Kirby only on the Native Broom (*Viminaria*

denudata), in November or December; *M. cruentata* Thoms. and *M. cuprifera* C. and G. on flowering stems of *Dillwynia floribunda*; while I have only taken *M. ignipicta* Kerr. by beating the dead leaves of Eucalyptus boughs. Mr. Froggatt records the breeding of *M. iridescens* Macl. (*nec* C. and G.) and *M. splendida* Don. (*purpurascens* F.) from infected boughs of *Acacia longifolia*. The latter is, however, commonly found on the widely spread *Acacia decurrens*.

The nomenclature of the genus is in a most chaotic state, and the clearing up of this tangle of names is a necessary preface to any future systematic work. The casual nature and "damnable iteration" of authors in the literature of the genus can be judged by the following. The name *costata* has been used by three authors—Macleay, Saunders and Thomson—for three different species, while *cupreovittata*, *intricata*, *obscura*, *purpureo-signata*, and *suturalis* have each been used twice. A hundred and ten names have been used in describing Australian species of *Melobasis*. This number is reducible to fifty after the more evident synonyms have been sunk. To this total seventeen new species are now being added, making the present total sixty-seven.

A visit to England in 1922 has enabled me to examine the types of Saunders, Blackburn and Kerremans contained in the British Museum of Natural History, as well as certain species of Thomson as identified by Kerremans. I owe much to the courtesy of Mr. K. G. Blair for his continuous help and advice at this institution. I am also indebted to Prof. Poulton, who kindly brought several of the Hope types to London for my examination, and whose hospitality at Oxford enabled me to complete my inspection of the Hope Museum. I have thus been able to identify most of the species, with the exception of those described by Thomson and *sexplagiata* C. and G.

I have also been greatly helped by the loan of collections from most of the Australian Museums, and I would here express my appreciation of the courtesy of the following gentlemen in this connection:—Mr. A. M. Lea and the Trustees of the South Australian Museum, for the loan of their numerous and valuable collections; Mr. J. Kershaw and Mr. Spry of the National Museum; Mr. Longman and Mr. Hacker of the Queensland Museum; Dr. Anderson and Mr. Musgrave of the Australian Museum; Prof.

L. O. Harrison and Mr. Shewan acting for the Macleay Museum, and Messrs. R. Illidge of Brisbane and J. Dixson of Melbourne, for the loan of private collections; while collectors like Messrs. H. Giles and J. Clark of Perth, and Mr. H. W. Brown have largely contributed. The collections of the first two of these were further valuable in the possession of several types or cotypes of Blackburn's species, while the two Sydney Museums contain those described by Macleay. I have thus had very long series and an enormous amount of material for inspection.

The species of *Melobasis* can be grouped by colour into two sections, *i. e.* (1) Concolorous and (2) Patterned species, though in a few cases the vagaries of colour variation have been a cause of confusion. Thus the widespread *M. purpurascens* F.—found from Queensland to South Australia, including Tasmania—includes forms that have been described under four other names.

Again *M. gratiosissima* Thoms. has colour varieties, especially of the prothorax, that include the forms described by Kerremans as *amabilis* and by Blackburn as *speciosa.*

With few exceptions I find the patterned species generally constant in colour. No less than nine of them have a pattern of a similar design, *i. e.* two shoulder marks, two fasciae (or substitutes for them) and a post-scutellary sutural mark. Yet there is less difficulty in their identification than is the case with concolorous species—notably in the bronze, non-costate species, where structure and sculpture form the sole criterion. Green and gold are often interchangeable in the metallic species, while more rarely the green is replaced by blue. Thus I have two beautiful blue varieties of *M. cuprifera* C. and G.

In some cases—notably in *purpurascens* F. and *gloriosa* C. and G.—there are variations in which the pattern is more or less obsolete, producing forms like *miranda* Kerr. of the former, and, as I think, *thomsoni* Blackb. of the latter. The long series examined show continuous forms of these variations, which include the species I have placed as synonyms. Indeed, *fulgurans* and *subfulgurans* of Thomson might also be considered as variations of *purpurascens* F., but these have been given the benefit of the doubt.

Mr. A. M. Lea has taken *purpurascens* at Lord Howe Island and also at Norfolk Island. Those from Lord Howe Island are generally similar to Australian examples, but the Norfolk Island specimens show considerable variation,

the pronotal vittae sometimes being outlined by fiery coppery lines, and the elytra and underside largely blue, the light green markings tending to obsolescence or to be coppery.

In general the underside is less variable in colour than the upper surface; and both colour and clothing of the underside are a great guide in identifying species otherwise similar. Thus *M. rotundicollis* is almost always purple coppery on the underside; the western *metallifera* Saund. can always be distinguished from the eastern *cuprifera* C. and G. by the nearly glabrous, and concolorous underside of the former and the densely albo-pilose coppery underside of the latter.

The elytral sculpture is subject to wide variation—with the limitation that in all cases some longitudinal arrangement of punctures or intervals (or of both) exists. One of the great difficulties in determining the older-named species is due to the lack of a clear—or any—description of this character; Blackburn being almost alone in giving details that suffice for identification in this respect. The species vary from being uniformly striate or seriate-punctate throughout, as in *M. cupriceps* Kirby, to those species where it is difficult to find any seriation at all, as in *M. uniformis*, n. sp.

The intervals again may be definitely costate as in *M. nervosa* Boisd., *M. lathami* C. and G., or lightly convex as in *M. prisca* Er., *andersoni* Blackb., or entirely flat. In many cases there is at least one interval more raised than any other, that limits what I have called the sub-sutural region—an area generally concave—often dotted with irregular punctures. The absence or presence of this concavity is characteristic and constant, being present to a marked degree in *M. nervosa* Boisd., *M. cupreo-vittata* Saund., *M. cruentata* Thoms., *M. nobilitata* Thoms., *M. meyricki* Blackb., *M. vertebralis* and *M. regalis*, n. spp. The scutellum varies very much in size and form. Quite frequently species of a similar facies may be easily separated on this character as, for example, with *suturalis* Macl. and *macleayi*, n. sp. (though there are many other differences).

History.—The name *Melobasis* first occurs in Castelnau and Gory's Monograph, 1841, to designate the "neuvième division" of the genus *Buprestis*, with the laconic diagnosis: "Antennes à dernier article non bilobé. Corps oblong, ovalaire. Corselet court, arrondi sur les côtés. Elytres

oblongues, denticulées le long du bord externe et à l'extremité (*Melobasis*)." *

Of the above six characters, five are found in many other genera of Buprestidae, while the remaining one, "Corselet—arrondi sur les côtes," is only true of some species.

The Monograph then gives the names of twelve species included in the group, viz. *conica* C. and G., *cuprifera* C. and G., *cupriceps* Kirby, with its synonym *viridinitens* Boisd., *propinqua* Hope, *lathami* Hope, *iridescens* Hope, *nervosa* Boisd., *chrysochloris* Hope, *gloriosa* Hope, *superba* Hope, *sexplagiata* C. and G., and *erythromelas* Boisd.

Of these the last is a *Stigmodera*, *chrysochloris* is a *Torresita*, while *conica* is now referred to *Briseis*, leaving nine, of which I have identified seven from types, *nervosa* Boisd. from an established tradition, and *sexplagiata* C. and G. from figure and description (*vide infra*). *M. cuprifera* C. and G. (= *propinqua* Hope) is the common Eastern species known in most collections with a long synonymy.

M. iridescens C. and G. This has been variously determined in Australian collections, and is frequently confused with the Sydney species *cruentata* Thoms. The type in the Hope Collection is labelled "Van Diemen's Land" and is clearly a variety of *cupriceps* Kirby, as stated by Saunders, in which the upper surface is irregularly suffused with blue, probably due to long immersion in spirits. There is a similar example in the British Museum bearing a label "N.H.," a second label, "compared with type," a third printed "Saunders 74–18." Normal examples of *cupriceps* measure 12 × 4 mm. I have, however, examples from Gympie (Q.) that are only 7 × 2½ mm.

M. lathami C. and G. The type in the Hope Museum is a unicolorous dark bronze colour, in which the elytral costae are not as strongly developed as usual, as in *soror* Blackb. (type). This species is widely distributed in Western Australia, and varies greatly in colour above and below, from bronze to bronze-green (*bicolor* and *laeta* Saund.) and bright green (*costipennis* Kerr.), the costae often showing a nitid bronze on a darker or green ground. The outline of the pronotum and elytra is not very unlike that of *simplex* Germ., but the punctures are coarser and less transverse, especially near the middle.

* For more complete diagnoses of the genus see Lacordaire (Hist. Nat. Ins., vol. iv, p. 46) or Kerremans (Gen. Ins., p. 357).

M. gloriosa C. and G. is also well known in Australian collections, of a convex, subcylindric form; its pattern is often varied. (See under *pulchra* Blackb. *infra.*)

M. superba C. and G. The type in the Hope Museum is the very beautiful species that I have seen from northern New South Wales (Dorrigo, etc.). It is labelled "N.H.," and is distinguished from other 7-plagiate species by its subcostate elytral intervals.

It may be noted here that the six species of Hope in the above Monograph were described in a paper apparently printed for private circulation in 1806 under the title "Synopsis of Australian Insects. Buprestidae," hence these six species are now credited to Castelnau and Gory for their first general publication. The Monograph also omitted *M. purpurascens* F.—the first of the genus described (1801) and probably taken to England by Banks or Solander—also figured by Donovan under the name of *B. splendida* in 1805 (Epit. Ins. New Holl.). It also omits the sub-legendary *M. chrysoptera* Boisd. (= ? *cuprifera* C. and G.

To this list Erichson in 1842 added *hypocrita* and *prisca* from Tasmania—also commonly found in Victoria—followed by Hope with *pyritosa* from W.A., *verna* from S.A., and *porteri* from Port Phillip in 1846 and by Germar in 1848 with *simplex* and *suaveola* from Adelaide—the last certainly synonymous with *verna.*

M. hypocrita Er. and *M. prisca* Er. were, I believe, correctly determined by the late Augustus Simson, whose exhaustive collection of Tasmanian Coleoptera is now in the South Australian Museum. Both are found in Victoria, the former also in New South Wales besides Tasmania. *Hypocrita* is easily recognised by its combination of bronze-black upper and fiery copper under surface, though confused by Kerremans with *vittata* Blackb.—a very different species. *Prisca* is a rather widely oval species, dark bronze-green in colour, with some of its elytral intervals slightly convex.

M. simplex Germ. An example marked "type" in the British Museum with an old label marked "*simplex* Ger., type, Adelaide," a round label marked "Adelaide 64" and a label printed "Saunders 74–18," is of a darker green (almost peacock-green) than usual, with coppery suture and margins to elytra, underside green. This scarcely corresponds with the "viridi-aeneus" of the description,

applied to both upper and lower surface. Long immersion in spirits would possibly account for this. It corresponds in sculpture and form with examples in the Adelaide Museum, one of which, labelled "*simplex* Germ." in Blackburn's handwriting, is almost identical with another example in the same collection labelled by him "*sordida* Blackb. (= *obscura* Saund.)." After an examination of a great number of specimens and the types of Saunders, Blackburn and Kerremans, I am compelled to the conclusion stated in the synonymy below. *Viridis* Saund., *semi-suturalis* Blackb., *concolor* Kerr. and *viridiventris* Kerr. being bright green examples, *vicina* Kerr. a darker green, *obscura* Saund. being bronze. The species is remarkable for the fine, close transverse sculpture of the pronotum, its sides abruptly narrowed behind—the colour varying in part, or wholly from green, brassy-green to bronze. The name has been misapplied to other green species in many Australian collections.

In 1858 Boheman published his *M. cyaneipennis*—renamed in 1871 by Macleay *azureipennis* when he described the "Insects of Gayndah," including also *M. apicalis*, *costata* and *obscura*. In 1886 Macleay described *M. suturalis* from New Guinea, and in 1888 *M. lauta* from King Sound. Of these *obscura* is an *Anilara*, and is the same species generally identified (probably correctly) as *A. platessa* Thoms. As Macleay—also in the "Insects of Gayndah"—described another *Anilara* as *Anthaxia obscura*, for which I propose the name *Anilara macleayi*, the following readjustment is necessary:—

Anilara (*Melobasis*) *obscura* Macl. = *A. platessa* Thoms.

Anilara macleayi nov. nom. for *Anthaxia obscura* Macl.

Macleay's *apicalis* and *costata* are widely distributed beyond the Gayndah habitat; *costata* occurring at least as far south as Victoria, and distinguished from its costate allies by smaller size, the presence of only two costae on each elytron and a tendency to green tint. *Suturalis* occurs in Northern Australia, is rare in collections, and has an unusually large scutellum for its size, though far removed in this respect from a *Diceropygus*.

In 1868 Saunders described *M. metallifera*, in 1871 *M. goryi*, and in 1876 and 1878 eight more species:—viz. *cupreo-vittata*, *costata*, *rubro-marginata*, *igniceps*, *laeta*, *viridiceps*, *obscura* and *viridis*. Of these *costata* is preoccupied by Macleay and was renamed *saundersi* by Masters in

1886. The same species, however, was described by Thomson in 1879 as *costifera,* which name thus takes precedence of *saundersi.*

Metallifera Saund. has been difficult to determine, having been confused *ab initio* by Saunders himself with *propinqua* C. and G. (= *cuprifera* C. and G.) when he placed his English description after Hope's Latin diagnosis (Trans. Ent. Soc. Lond., 1868, p. 16), and added to the confusion by an erroneous statement as to the geographical distribution of *propinqua. Metallifera* is quite distinct from *cuprifera* C. and G. chiefly by its very different under surface, which is nitid coppery, "cupreo-aenea nitido," in description, sparsely pilose; whereas in *cuprifera* the underside is so densely pilose that any sheen is entirely obscured. The distinction is constant and in no case (of the numerous examples examined) is difficult to determine. *Cuprifera* C. and G. is only known from the eastern states, Queensland, New South Wales, Victoria, Tasmania and South Australia, but *metallifera* Saund. only from Western Australia.

The above confusion appears also in the search for the type of Hope, evidently used by Saunders. Two specimens are labelled "*metallifera*" in the Hope Collection, one of which is the western species, the other the eastern. The last words in Hope's description together with the locality, Swan River, brings my research to the conclusion stated above—the labelling of the presumed types of these two species having probably been confused.

Laeta and *rubro-marginata* are two of the multi-coloured forms of the common western *lathami* C. and G.

Obscura and *viridis* are varieties of *simplex* Germ.; *viridiceps* is allied to, but distinct from, *simplex,* with coarser punctures on pronotum and elytra, the former widest at, or in front of, middle.

Igniceps is a western species I have seen from Perth, Kellerberrin, and Cunderdin, combining large size, subparallel (acuminate at apex) form, the apices fiery copper, elytra with marked subsutural concavity. Before seeing the type I had described this in MSS. for examples in the Sydney and Melbourne Museums.

In 1879 Thomson described twenty species, giving inadequate details and little reference to the work of others. His paper "Typi Buprestidarum Musaei Thomsoniani," App. 1*a*, was overlooked by Masters and also, I think, by Blackburn in 1887, though referred to by him in 1890.

There is much repetition; thirteen, at least, of his names being redundant as in synonymy *infra.*

M. cruentata Thoms. (frequently labelled "*iridescens* C. and G." in Australian colls.). There is a remarkable sexual difference of colour in this species, well known to collectors around Sydney. The female is concolorous bronze, generally much larger than the male; and in fresh specimens the pattern of the male is faintly indicated, in certain aspects, on the surface of the elytra. As it is undescribed the following description is desirable.

♀. Dark bronze, moderately nitid, above and below, elytral margins finely coppery, antennae and tarsi blue. Head and pronotum coarsely punctate, the sides of the latter widely rounded, its disc sulcate, two smooth subnodulose spaces close to, one on each side of, sulcus, base feebly, apex strongly bisinuate. *Elytra* everywhere clearly punctate, the punctures fine near suture, coarser and more rugose at sides, linear arrangement only indicated by some smooth obsolete costae, and two clearly convex intervals (a short scutellary, and a long one subsutural); the subsutural area corresponding with the coppery part in the ♂. *Underside* finely punctate, with a fine, rather dense pubescence.

Dim. 11–16 × 5–6 mm.

Found in September to October on flowers of *Dillwynia floribunda* in Sydney district.

M. innocua Thoms. Specimens so determined by Kerremans are, I consider, but green variations of *obscurella* Thoms. (*rotundicollis* Blackb.). There is, however, in the British Museum a long series of a species from Yallingup, W.A., that corresponds with Thomson's region and meagre description. This I prefer to consider as *innocua* Thoms., rather than add another bewildering name, until Thomson's type can be compared with it.

In this species the pronotum is moderately rounded at sides, the punctures thereon being coarse, round and close, subconfluent and transverse at sides, with a short, smooth, median space near base. The elytral intervals as in *simplex* Germ., intermediate area—outside the subsutural interval—striate-punctate.

M. obscurella Thoms. var. *ignicollis* n. var.

Much larger than typical form, oblong oval. Head, pronotum, scutellum and underside fiery coppery; elytra green or greenish-purple, intervals clearly convex.

Dim. 13 × 4½ mm.

Hab. South Australia.

Two female examples in the South Australian Museum—amongst the hundred examples examined of the above species—stand out so conspicuously in size and colour as to deserve notice. There is no special locality label attached, but to each there is a label containing date, with, apparently, a MS. name, in the handwriting of Mr. Tepper (?).

M. cupreo-vittata Thoms. nom. pracocc. = *vittata* Blackb. The name affinis, proposed by Kerremans for this, being rendered unnecessary by the precedence of Blackburn's *vittata*. I think I know the remaining seven species described by Thomson cxcept *placida*, identified by Kerremans for an example which I consider is conspecific with *subcyanea* Blackb. and *coeruleiventris* Kerr. Blackburn described twenty-one species, of which thirteen were published in 1887, four in 1891, three in 1892, and one in 1901. I have examined the types of these, and find ten of them to be synonyms (see below).

M. pulchra Blackb. I was at first disposed to regard this, of which I have examined the type, as a valid species, but a long series of *M. gloriosa* C. and G., sent by Mr. J. Clark from Perth, show forms that include Blackburn's species. The ground-colour of the elytra varies (in *gloriosa*) from reddish-purple to deep violet, the markings and underside from green to golden or coppery, while the pronotum is variously marked with a more or less distinct vitta.

Subcyanea, *intricata* and *bellanensis* are all, I consider, variations of *fulgurans* Thoms. A short wide form, thorax often blue or green with purple vitta, or vaguely purple markings; the type of the first is blue suffused purplish on pronotum, elytra purple with indications of green. The vagaries of variation, as shown in the long series of the South Australian and British Museums, seem to connect *fulgurans* with *purpurascens* F., but probably the wider form—especially of the pronotum—make the distinction given in my table more satisfactory.

Thoracica Blackb. has the facies of *iridicolor* Cart., but is dingier; the head, thorax and underside dark green, legs and antennae blue, elytra purple blueish; the disc of pronotum sparsely punctured, the elytra clearly seriate-punctate throughout, the seriate punctures large, intervals flat and punctate.

M. intricata Blackb. (nom. praeocc. by Deyrolle for a New Guinea species—identified by me from Banks Island) = *fulgurans* Thoms. Kerremans' name for this, *blackburni*, is thus superfluous.

Blackburn also provided the name of *sordida* for the preoccupied *obscura* of Saund., and *thomsoni* (*vide supra*) for *purpureo-signata* Thoms., but the former is superfluous, while the latter corresponds with some varieties of *gloriosa* C. and G.; this leaves eleven valid species by Blackburn.

Lastly, Kerremans has published the descriptions of twenty-two new Australian species, of which seventeen appeared in 1898, the rest in 1900 and 1902, besides those of species from New Guinea and other regions outside Australia. As he seldom described "sculpture" in any detail, never tabulated the genus nor even his own species, I found them difficult to identify, until able to examine his types. This author seems to have made little allowance for the wide variation that takes place. (See synonymy below.)

M. ignipicta Kerr. occurs, at least, in New South Wales and Victoria, and is, I think, the species referred to by Blackburn (Linn. Soc. N.S.W., 1891, p. 498) as the possible female of *monticola* Blackb. I have seen a good many of both sexes of both species, but have not yet met with *monticola* from anywhere outside Victoria. Besides certain colour differences, the elytra of *monticola* are evidently more costate than those of *ignipicta*, while in female specimens the apical segment of abdomen is more narrowly arcuate in *monticola*.

M. terminata Kerr. is a species I took on Acacia foliage at Cottesloe, W.A.—though described from Victoria. One of the smallest, it is remarkable for its flat surface and almost entire absence of any linear sculpture; the apex, sometimes the suture, coppery, while in two (out of seven) examples there is a coppery vitta on each side of, and parallel to, the suture.

Melanura from West Australia is near, but distinct from, *obscura* Saund. (var. of *simplex*). The type is black-bronze above and below, with the elytral intervals flat (no costate intervals), but other examples show one or two feebly convex intervals.

Nigrita is a smooth, dark green-bronze species near *prisca* Er., but the pronotal punctures are fine and sparse, the elytral intervals less elevated, the punctures finer.

The sides of thorax are a little widened behind the middle. There are examples in the Queensland Museum from the Northern Territory. It is also near *elderi* Blackb. and *incerta* Kerr.

Callichloris is a small brassy-green species—the tips of elytra coppery, the prothorax straight in front, sides rounded, disc evenly and closely covered with fine, round punctures. The elytral punctures are fine and irregular—scarcely seriate; transverse on apical half except near suture, the intervals nearly flat.

Cupricollis is very near the type of *viridiceps* Saund., but the pronotal punctures are finer and closer—though less so than in *simplex* Germ., which it resembles in outline. I cannot match it elsewhere.

Aenea is near *thoracica* Blackb., but with prothorax dark bronze instead of green, its sides nearly straight, its surface finely punctured. The elytra are seriate-punctate throughout, the suture being tinged coppery, the seriate punctures larger than in *cupriceps* Kirby, smaller than in *thoracica*.

M. jacowleffi from New Guinea is very near and is possibly a variety of *suturalis* Macl., but is a more concolorous green colour, with the apex purplish. The scutellum and form agree with my example of *suturalis* Macl. (compared with type).

M. fairmairei is near *incerta* Kerr., but the colour is darker and the elytra have three subobsolete but clearly traceable costae on each.

In the description of *viridicollis* the author compares it with *cupreo-vittata* Saund. This is unintelligible, since the two species are evidently widely different. Kerremans evidently meant to quote *cupreo-vittata* Thoms., and *viridicollis* is but one of the many varieties I have seen of Thomson's species (*vittata* Blackb. of my table).

M. incerta Kerr. I have referred three examples from Cape York in the South Australian Museum, and one in the National Museum, Melbourne (from N.W. Australia), to this species—described originally from New Guinea. It is near, possibly identical with, *M. elderi* Blackb. Two examples taken by Mr. G. E. Bryant at Cairns are close to the type of *incerta*.

I have determined, from description, specimens in my collection from Banks Island (Torres Strait) as *M. intricata*

Deyr., 3 ex. (♀♀) and *M. ignicauda* Kerr., 2 ex. (♂♂), both described as from New Guinea. If my identification be correct, it is probable that the latter is the male, the former the female of the same species. There is only the difference of ground-colour to separate them, *ignicauda* being chiefly golden and *intricata* blue. There is also one example of *M. suturalis* Macl., described from New Guinea, in the Macleay Museum, labelled "Cape York." There only remains, so far as I know, one other species, described from Australia, viz. *M. chrysomelina* Thery—of strikingly beautiful colour (violet with green elytra) and broad obovate form—of which there is a single female example in the National Museum, Melbourne. and two in the British Museum.

Tabulation.—I find it difficult to distinguish all the species by the few words that are convenient in such a table—in view of the wide variations in colour; but the tabulation given below will facilitate identification in a difficult group. Thus *macleayi* and *terminata* on *some* examples might well go into Group II, Section C, but many examples of these are almost uniformly green. Again *meyricki* might be included in Section B; but typical specimens more fitly belong to Section C. Any tabulation is only possible on normally coloured specimens.

Synonyms are omitted; also species either unknown to, or imperfectly identified by, the author.

TABLE OF *MELOBASIS*.

Group. I. Species having Prominent Costae on Elytra.

Section A. Elytra more or less Unicolorous.

1–3. Each elytron with 3 or 4 costae.

2. Pronotum often greenish or bluish, sides rounded, widest in or before middle . . . . *nervosa* Boisd.

3. Pronotum clear bronze, widest at base, sides nearly straight. *costifera* Thoms.

4–6. Each elytron with 2 distinct costae.

5. Colour greenish-bronze, sides of pronotum rounded. *costata* Macl.

6. Colour bronze to golden green, sides of pronotum nearly straight, apices of elytra often coppery . . . *lathami* C. and G.

7. Elytra irregularly undulate-costate . . . *abnormis*, n. sp.

Section B. Elytra Patterned or Variegated.

1–4. Elytra bronze (blueish), each with 4 costae.
2. Costae sharply defined, in places coppery. *interstitialis* Blackb.
3. Costae wider; intervals in places green or coppery. *cupreo-vittata* Saund.
4. Elytra coppery, suture and margins blue . *vertebralis*, n. sp.
5. Each elytron with 2 distinct costae, suture and 4 spots green. *quadrinotata*, n. sp.

Group II. Species without Prominent Costae.

Section A. Elytra Bronze—more or less Unicolorous.

(*Apices sometimes tinged with metallic colours.*)

1–9. Several elytral intervals convex.
2–4. Intervals more strongly convex, form ovate.
3. Colour clear bronze . . . . *andersoni* Blackb.
4. Colour bronze-green to green . . . . . . *prisca* Erichs.
5–9. Intervals of elytra feebly convex.
6–8. Upper surface bronze-black, form depressed.
7. Underside fiery coppery . . . . *hypocrita* Erichs.
8. Underside bronze-black, intervals nearly flat . *melanura* Kerr.
9. Upper surface bronze, apical margins blue, form convex. *rothei* Blackb.
10–13. Elytra with one or two subcostate intervals.
11. 17–23 mm. long, convex, sides of pronotum widely rounded. *robusta*, n. sp.
12. 16 mm. long, depressed, sides of pronotum nearly straight. *fairmairei* Kerr.
13. 10–12 mm. long, form like *simplex* Germ., but with coarser punctures, head and legs green . . . *viridiceps* Saund.
14–16. Subsutural concavity limited by a single raised interval.
15. Navicular, apex coppery, elytral punctures close and fine. *igniceps* Saund.
16. Cylindro-conic, elytra suffused with blue, punctures coarser and more distinct . . . . *subconica*, n. sp.
17–24. Intervals of elytra flat.
18. Underside subglabrous, pronotum very convex. *cuprina* Kerr.
19. Underside very pilose, elytra sculpture without linear arrangement . . . . *uniformis*, n. sp.
20–24. Elytra clearly striate-punctate, colour greenish-bronze.
21. Form ovate, pronotum sparsely punctate, sides obliquely narrowed to apex, elytral intervals flat and impunctate. *incerta* Kerr.

22–24. Form oblong.

23. Pronotum strongly punctate, narrowing behind . *elderi* Blackb.
(Elytral intervals wrinkled) . . . . *nigrita* Kerr.

24. Pronotum finely, closely punctate, sides lightly rounded; seriate punctures large, apex and suture violaceous.
aenea Kerr.

GROUP II. SECTION B.

ELYTRA METALLIC GREEN, COPPERY, BLUE OR PURPLE.

1–5. Elytra irregularly punctate, seriation little evident.

2–4. Colour coppery or golden green (rarely blue).

3. Underside coppery and densely pilose . . *cuprifera* C. and G.

4. Underside subglabrous and nitid . . . . *metallifera* Saund.

5. Pronotum and underside bronze, elytra golden.
bimetallica, n. sp.

6–13. Elytra with some convex intervals; vaguely seriate-punctate (*obscurella* Thoms. and allied species—about 9 mm. long).

7–10. Sides of pronotum rounded, underside, in general, fiery coppery, pronotum rather flat.

8. Above blue-green or violaceous . . . . *obscurella* Thoms.

9. Above obscure purple, pronotum convex and transversely punctate . . . . *nitidiventris* Kerr.

10. Metallic green above and below. . *innocua* Cart. (? Thoms.).

11–13. Above green-bronze or bronze-green, sides of pronotum nearly straight.

12. Apex often purple, all elytral intervals flat . *apicalis* Macl.

13. Elytral margins often coppery, some intervals convex.
occidentalis, n. sp.

14–18. Elytral costae subobsolete, colour green, bronze-green or bronze, sides of pronotum nearly straight, abruptly narrowed behind (except in *picticollis*). *Simplex* Germ. and allies, 9–12 mm. long.

15. Pronotum finely, transverse-punctate. Elytra irregularly punctate . . . . *simplex* Germ.

16–18. Elytral punctate coarser than 15, with some linear arrangement.

17. Pronotal punctures small, round and separate.
cupricollis Kerr.

18. Pronotum not abruptly narrowed behind, generally in part violaceous . . . . *picticollis*, n. sp.

19. Sides of pronotum evenly rounded, its punctures close and round . . . . *callichloris* Kerr.

20. Elytral intervals flat (5–6 mm. long) . . *terminata* Kerr.

21–31. Elytra clearly striate-punctate throughout.

22–24. Upper surface coppery or golden green.

23. Sides of prothorax oblique, head wider than apex of prothorax. *cupriceps* Kirby.

24. Sides of prothorax rounded, head narrower than apex of prothorax . . . . *derbyensis* Blackb.

25–27. Upper surface green, elytra sometimes partly cyaneous, suture golden.

26. Nitid, sparsely punctate, scutellum large . . *suturalis* Macl.

27. Subnitid, densely punctate, scutellum small . *macleayi*, n. sp.

28. Pronotum and underside green, elytra purplish, base of pronotum strongly bisinuate . . . . *thoracica* Blackb.

29–31. Bicolorous.

30. Pronotum golden, elytra blue, 8–10 mm. long. *cyaneipennis* Boh.

31. Pronotum violet, elytra green suffused purple, 15 mm. long. *chrysomelina* Thery.

SECTION C. ELYTRA PATTERNED OR VARIEGATED.

1–5. Pattern, in general, consisting of 3 light fasciae alternating with 3 dark.

2–4. Form ovate.

3. Elytral intervals (2 at least) subcostate . . *superba* C and G.

4. Elytral intervals subconvex . . . . *fasciata*, n. sp.

5. Form cylindric, intervals flat . . . . *gratiosissima* Thoms.

6–22. Pattern, in general, consisting of 7 light markings on dark ground.

7–11. Form ovate, light markings fiery coppery.

8. Pronotum coppery, ground-colour of elytra blue. *sexplagiata* C. and G.

9–11. Ground-colour of elytra nearly black, light markings much smaller.

10. Underside glabrous, some elytral intervals convex. *monticola* Blackb.

11. Underside pilose, elytral intervals flat . . . *illidgei*, n. sp.

12–14. Pronotum green with purple vittae, elytra with green markings on purple ground; underside green.

13. Size smaller, elytral intervals flat (or nearly so), ground-colour dark purple . . . . *purpurascens* F.

14. Size larger, some elytral intervals convex, elytra coppery purple with variably obsolete green pattern . . *fulgurans* Thoms.

15–17. Elytra with seven golden " plaga " on blue ground.

16. 15 mm. long, underside strongly pilose, apex normal. *regalis*, n. sp.

17. 10 mm. long, underside lightly pilose, apex pisciform. *nobilitata* Thoms.
18–22. Form cylindro-conic.
19. Pronotum convex, the middle strongly produced in front. *gloriosa* C. and G.
20–24. Pronotum sub-depressed, only produced at angles in front.
21. Underside golden, elytral markings green or golden. *formosa*, n. sp.
22. Underside dark, elytral markings steel-blue. *septem-plagiata*, n. sp.
23. Elytra with 2 blue vittae and post-apical fascia on golden ground . . . . *dives*, n. sp.
24. Elytra with a single, postmedial fiery spot, form and colour very similar to *monticola* Blackb. . . *ignipicta* Kerr.
25–27. Elytral pattern limited to vittae.
26. Coarsely punctate, pronotum channelled, its sides rounded, underside pilose—sexually coloured . . *cruentata* Thoms.
27. Finely punctate, pronotum not channelled nor rounded, underside glabrous . . . . *vittata* Blackb.
28–30. Form cylindro-acuminate.
29. Elytra dark coppery, apex and suture blue . *caudata*, n. sp.
30. Elytra metallic green, apex purple . . . *meyricki* Blackb.
31–36. Elytra striate-punctate, intervals flat.
32. Elytral margins and base golden, middle blue . *lauta* Macl.
33. Elytra varicoloured, green, purple, blue, little-defined. *iridicolor*, n. sp.
34–36. Elytral apices violaceous, this colour advancing to the third anterior in three branches.
35. Pronotum and base of elytra golden green . *ignicauda* Kerr.
36. Pronotum and base of elytra blue . . . . *intricata* Deyr.
(N.B.—35 and 36 are possibly male and female of same species.)

Synonymy.—In each case the name standing first has priority.

M. purpurascens F.	= *splendida* Don.
	= *purpureo-signata* C. and G.
	= *faceta* Thoms. (det. by Kerr.).
	= *miranda* Kerr.
M. cuprifera C. and G.	= *propinqua* C. and G.
	= *porteri* Hope.
	= *goryi* Saund.
	= *verna* Hope (var.).
	= *suaveola* Germ.
	= *prasina* Thoms.

M. cupriceps Kirby	= *viridinitens* Boisd.
	= *iridescens* C. and G. (var.).
M. fulgurans Thoms.	= *sub-fulgurans* Thoms.
	= *placida* Thoms. (as det. by Kerr.).
	= *intricata* Blackb. (nom. praeocc.).
	= *blackburni* Kerr.
	= *beltanensis* Blackb.
	= *sub-cyanea* Blackb.
	= *coeruleiventris* Kerr.
M. lathami C. and G.	= *serratula* Hope.
	= *rubro-marginata* Saund.
	= *laeta* Saund.
	= *bicolor* Blackb.
	= *costipennis* Kerr.
	= *soror* Blackb. (var.).
M. cruentata Thoms.	= *puncticollis* Blackb.
M. gloriosa C. and G.	= (var.) *pulchra* Blackb.
	= ? *purpureo-signata* Thoms. (nom. praeocc.) = *thomsoni* Blackb.
M. sexplagiata C. and G.	= *pyritosa* Hope.
	= *pretiosa* Blackb.
	= *auro-notata* Kerr.
M. hypocrita Erichs.	= *acuta* Kerr.
M. prisca Erichs.	= *semi-striata* Blackb.
M. simplex Germ.	= *viridis* Saund.
	= var. *obscura* Saund. (nom. praeocc.).
	= *sordida* Blackb.
	= *semi-suturalis* Blackb.
	= *concolor* Kerr.
	= *viridiventris* Kerr.
	= *vicina* Kerr.
M. cyaneipennis Boh.	= *azureipennis* Macl.
	= *aureipennis* Thoms.
M. apicalis Macl.	= *suturalis* Thoms.
M. suturalis Macl.	= ? *jacovleffi* Kerr.
M. obscura Macl.	= *Anilara obscura* Macl.
	= *A. platessa* Thoms. (as det. by Carter).
	= *A. uniformis* Kerr.
	= *A. cuprescens* Kerr.

The last two (types examined) are evidently forms of the common Eastern species generally known in Australian collections as *A. platessa* Thoms.

M. cupreo-vittata Saund. = *vittigera* Thoms.
= *obsoleta Thoms.*
M. costifera Thoms. = *costata* Saund. (nom. praeocc.).
= *saundersi* Mast.
M. interstitialis Blackb. = *costata* Thoms. (nom. praeocc.).
M. *vittata* Blackb. = *cupreo-vittata* Thoms. (nom. praeocc. *affinis* Kerr.
= *inflammabilis* Thoms.
= *viridicollis* Kerr.
M. obscurella Thoms. = *rotundicollis* Blackb.
= *viridiobscura* Thoms. (as ident. by Kerr.).
M. gratiosissima Thoms. = *violacea* Kerr.
= *speciosa* Blackb.
M. elderi Blackb. = *nigrita* Kerr.
M. intricata Deyr. = ? *ignicauda* Kerr.

In the case of *purpureo-signata* C. and G., *goryi* Saund., *viridinitens* B., *serratula* Hope, *suaveola* Germ., *prasina* Thoms., *aureipennis* Thoms., *suturalis* Thoms., I have followed other authors. For the greater part I have depended on the examination of types in conjunction with that of long series from various collections.

Distribution.—While found all over Australia, the warmer regions are evidently the stronghold of *Melobasis* with a Zoo-centre in Western Australia—the region that is freest from exotic faunal invasion. The accompanying table, showing the distribution of species, the habitat of which is known to me, gives the following result.

Total number of known species, 67.

Species of which exact habitat unknown, 4.

	No. of Species.	No. of species found only in that State.
Western Australia . . .	30	22
Queensland and N.T. . .	23	10
New South Wales . . .	19	2
Victoria	22	3
South Australia	15	0
Tasmania	10	0
Exact habitat unknown . .	4	—

Thus Western Australia has 48 per cent. of the total number of species, while 35 per cent. are peculiar to that region. Queensland has 37 per cent. of the total, with 16 per cent. of endemic species. Tasmania has only 16 per cent. of the total, of which none are endemic, pointing to the comparatively recent extension to, or less suitable environment of the genus in the island.

Species	Queensland.	N.S.W.	Victoria.	Tasmania.	S. Australia.	W. Australia.	N. Territory.	Species.	Queensland.	N.S.W.	Victoria.	Tasmania.	S. Australia.	W. Australia.	N. Territory.
nervosa B.		×	×	×	×			*picticollis*, n. sp. .		×	×	×			
costifera Th. . .	×				×	×		*apicalis* Macl. . .	×						
costata Macl. . .	×	×	×					*caudata*, n. sp. . .						×	
lathami C. and G. .			×		×	×		*terminata* Kerr. . .						×	
interstitialis Bl. . .						×		*obscurella* Th. . .		×	×	×	×		
cupreo-vittata Saund.			×		×	×		*thoracica* Bl. . . .			×				
vertebralis, n. sp.. .	×	×						*cupriceps* Kby. . .	×	×	×	×			
cupricollis Kerr. ?								*derbyensis* Bl. . .						×	
quadrinotata, n. sp. .	×							*suturalis* Macl. . .	×						
andersoni Bl.. . .					×	×		*macleayi*, n. sp. . .	×	×					
prisca Er. . . .			×	×				*cyaneipennis* Boh. .	×						
hypocrita Er.. . .		×	×	×				*chrysomelina* Thery..	×						
rothei Bl.					×	×		*sexplagiata* C. and G.			×		×	×	
robusta, n. sp. . .						×		*gratiosissima* Th. .	×	×	×		×	×	
simplex Germ. . .			×	×	×			*monticola* Bl. . .			×				
innocua Th. . . .						×		*illidgei*, n. sp. . .	×						
igniceps Saund. .						×		*purpurascens* F. .	×	×	×	×	×		
subconica, n. sp. .						×		*cruentata* Th. . .		×	×				
elderi Bl. . . ?	×					×		*fulgurans* Th. .	×	×	×	×	×		
cuprina Kerr. . .						×		*nobilitata* Th. . .						×	
uniformis, n. sp. .						×		*gloriosa* C. and G. .						×	
cuprifera C. and G. .	×	×	×	×	×			*superba* C. and G. .		×					
melanura Kerr. . .						×		*septem-plagiata*, n.sp.						×	
metallifera Saund. .						×		*dives*, n. sp. . . .							×
bimetallica, n. sp. .						×		*formosa*, n. sp. . .						×	
nigrita Kerr. . .	×							*vittata* Bl. . . .	×	×	×		×		
ignicauda Kerr. .	×							*meyricki* Bl. . .						×	
intricata Deyr. . .	×							*lauta* Macl. . . .						×	
fairmairei Kerr. ?								*iridicolor*, n. sp. .	×						×
nitidiventris Kerr. .			×					*ignipicta* Kerr. .		×	×				
aenea Kerr. . . ?								*regalis*, n. sp.. . .						×	
abnormis, n. sp. .						×		*callichloris* Kerr. ?							
occidentalis, n. sp. ..					×	×		*trifasciata*, n. sp.. .	×	×	×				
viridiceps Saund. .		×													

The following are new species.

Melobasis vertebralis, n. sp.

Navicular, convex laterally. Head and pronotum bronzy-blue, the former thickly, the latter at the sides very sparsely tomentose; elytra coppery-bronze; sutural area, posterior margins and apex steel-blue, as also the underside, legs, antennae and tarsi; beneath strongly tomentose.

Head densely punctate, eyes large and prominent (head wider than apex of pronotum).

Prothorax apex subtruncate, base feebly bisinuate, sides nearly straight, all angles slightly produced, anterior rectangular, posterior rather widely acute; disc lightly and rather distantly punctate on medial area, closely and subrugose laterally; medial line obsolete, a large, shallow basal fovea and two smooth spots, one on each side of middle towards apex.

Scutellum transversely oval, depressed in middle, generally nitid coppery.

Elytra slightly enlarged behind shoulder, thence gradually and finely narrowed to apex; posterior margins strongly serrated; apices separately rounded, each elytron with the suture lightly costate and four equidistant costae; the sutural costa forked and diverging behind scutellum, the 2nd costa more raised than the rest (forming the limit of blue area) continuous to apex, 3rd, 4th and 5th little raised, 3 and 5 converging behind, the 4th shorter; interspaces clearly and closely punctate, showing a tendency to transverse rugosity towards shoulders; the punctures fine in sutural region, coarser laterally. Underside densely and finely punctate; the sculpture largely concealed by tomentum, ♂ with apical segment truncate between spines, ♀ with two spines close together.

Dim. ♂, 14 × 4 mm.; ♀, 15–17 × 5–5½ mm.

Hab. Queensland, Duaringa (*Aust. Mus.*); Ipswich (*Macleay Mus.*).

Six examples (2 ♂, 4 ♀) of this fine and distinct species in the above Museums. (Three examples also in Coll. Bryant, two from Baan-Baa, N.S.W.; one from Brisbane.) Allied to *nervosa, cupreo-vittata* group, it is readily determined by its bicolorous elytra, with its less strongly raised costae (except that next to sutural costa), its finer surface punctures, and straight-sided prothorax. Types in Australian Museum, Sydney.

Melobasis quadrinotata, n. sp.

Oblong ovate, subdepressed; head and pronotum dark bronze, the former sparsely albo-pilose, the latter pilose at sides only; elytra coppery-bronze with the suture and four maculae green, two humero-basal, filling the triangular depression between the humeral callus and first costa; two medial, pear-shaped, the narrow part pointing forward between the second costa and the sides, apex steel-blue, underside fiery coppery in the middle, abdominal segment and sides blue, legs coppery, tarsi and antennae steel-blue.

Head densely punctate.

Prothorax apex strongly, base lightly bisinuate, sides rounded, all

angles produced, the anterior acute, posterior subrectangular; disc closely and coarsely punctate, rugose and pilose at sides, a smooth medial line terminating in an elongate basal fovea.

Scutellum coppery, cordate.

Elytra widening behind shoulders, three and a third times longer than prothorax, the suture carinate for the greater part, a short scutellary and two other well-raised costae, the 1st originating near base at first parallel to the scutellary costa then to suture, joining the 2nd costa near apex and a little undulate anteriorly; the 2nd costa starting a little in front of medial spot; traces of a third obsolete costa seen on medial spot and joining the 2nd costa near apex; interspaces without any sign of seriate punctures, being more or less covered with a fine, dense transverse rugosity, the sutural area alone with close irregular punctures; the costae themselves bearing a few sparse punctures. Sternal region finely punctate, abdomen striolate; albo-pilose at sides; apical narrowly arcuate between two short spines.

Dim. 15 × 5 mm.

Hab. QUEENSLAND, Townsville (*National Museum, Melbourne*).

A single ♀—the type—is an ally of *M. cupreo-vittata* Saund. and *M. nervosa* Boisd., the form and elytral sculpture most like the latter. The distinct pattern of elytra and the coppery underside easily distinguishes it from both.

Melobasis robusta, n. sp.

Convex, robust, concolorous bronze, subnitid above glabrous and more shining beneath.

Head subconfluently punctate, scarcely pilose, eyes not very prominent.

Prothorax convex, strongly bisinuate at apex, base subtruncate, sides widely rounded, widest about middle, anterior angles rounded and depressed, posterior with a small blunt tooth; medial channel clearly cut in two examples (♀), or indicated by a smooth line in another example (♀), or obsolete in the fourth example (♂): disc coarsely punctate—the punctures close in the middle, subconfluent and rugose on sides; anterior medial lobe slightly depressed, the disc subgibbous behind this with a smooth space on each side of middle.

Scutellum elongate ovate, convex, smooth.

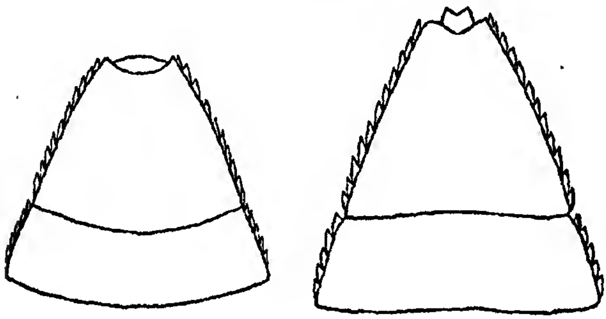
Elytra anterior two-thirds subparallel, posterior third finely denticulate at margin, apices separately rounded; coarsely and densely punctate, the punctures round and deep—at sides showing

a tendency to confluence, with transverse rugosity; each with three or more subobsolete costae; of these the sutural, the subsutural and a lateral more evident, but these obsolescent towards apex. Underside everywhere coarsely punctate, the punctures smaller towards apex of abdomen. In the ♂ the last segment widely arcuate between two short teeth, in the ♀ this segment more produced and terminated by a narrower arcuate excision.

Dim. ♂, 17 × 6½ mm.; ♀, 21–23 × 7–8½ mm.

Hab. Western Australia, Kellerberrin (*J. Clark* and *J. Crawshaw*); Cunderdin (*R. Illidge*).

Six examples are before me—four from Mr. Clark, two in Coll. Illidge. It is the largest species known to me, and



a ♂ b ♀

Melobasis robusta. (*a*) Apical segments of ♂.
(*b*) „ „ „ ♀.

from its different apical structure might be generically separated from *Melobasis.* This difference (shown in figs.), combined with its large size and nearly glabrous underside, should render it easily recognisable. Type in Coll. Carter.

Melobasis subconica, n. sp.

Cylindro-conical, bronze; head, pronotum and underside coppery-bronze; the base and middle of elytra suffused with blue; antennae and tarsi black; head and underside sparsely albo-pilose.

Head densely punctate, eyes prominent, their inner margins slightly converging behind, a short smooth carina on vertex.

Prothorax transverse, lightly bisinuate at apex and base, anterior angles obtuse, posterior acute—both a little produced—sides

lightly converging in front, nearly straight on posterior half; medial line feebly impressed in parts; diso with rather coarse round punctures, clearly separated at middle, becoming closer and rugose at sides.

Scutellum small, triangular, lateral margins raised.

Elytra slightly rounded and widening at shoulders, sub-obliquely narrowed on apical half, posterior margins and apex strongly serrate, apices separately rounded, coarsely punctate, with little evident seriation; suture carinate behind, subsutural concavity moderately developed, limited externally by a rather wide, slightly raised line, smoother than the rest of elytra (the punctures more sparse); this line bifurcating in the middle, the one branch continued obliquely to the humeral callus, the other running parallel to the short scutellary subcosta. Some linear arrangement of the punctures to be seen immediately outside the subsutural area, but somewhat confused by irregular punctures of the same size; the sculpture transverse and rugose towards the base and sides. Underside sparsely punctate, apical segment of abdomen truncate between two short, stout spines.

Dim. ♂, 12 × 4 mm.; ♀, wanting.

Hab. WESTERN AUSTRALIA, Geraldton (*H. W. Brown*).

Mr. Brown has generously given me one of a pair taken by him. It is nearest *uniformis* and *cuprina* Kerr., though the exigencies of tabulation place it next to *igniceps* Saund. The less uniform colour distinguishes it from both of these, while it is further separated from *uniformis* by conical form, more marked subsutural concavity, larger and sparser puncturation of upper surface, together with, at least, *some* linear arrangement of its sculpture; from *cuprina* Kerr. it is clearly separated by the form of the pronotum.

Melobasis uniformis, n. sp.

Rather widely ovate, silky bronze, apex sometimes coppery, head and underside coppery and densely albo-pilose, antennae and tarsi blueish—sometimes fuscous.

Head narrower than apex of prothorax, densely punctate.

Prothorax convex, apex notably, base lightly bisinuate, sides moderately rounded, angles a little produced, the anterior subrectangular, posterior acute; disc slightly depressed at middle on basal half, a large basal fovea; medial sulcus indicated here and there; disc with deep, round punctures, finer and sparser in middle, larger and closer on intermediate area, densely, transversely rugose-punctate laterally.

Scutellum rather large and oval.

Elytra evenly convex transversely, slightly wider than prothorax at base, sides parallel on basal half, thence converging to apex; posterior margins finely serrate, apices separately rounded, suture depressed behind scutellum, carinate on apical half, whole surface densely and clearly punctate, the punctures finer towards sides and apex, the linear series by the equally punctured intervals on the same level, some fine transverse rugosity apparent only near humeral region; in some examples two obscure longitudinal convex lines indicated. Beneath, the evident coarse punctures of prosternum and the finer punctures on abdomen largely hidden by the unusually long, recumbent hair; last segment of ♂ rather narrowly truncate between two short spines, of ♀ arcuately excised.

Dim. 13–15½ × 4½–5½ mm.

Hab. Western Australia, Beverley (*F. DuBoulay*); Swan River (*A. M. Lea*); W. A. (*Blackburn Coll.*).

Six examples, including both sexes, show an undescribed species with the following combination of characters. Large size, evenly convex upper surface (elytra without subsutural concavity) almost everywhere, with dense, round, punctures without evident longitudinal arrangement; underside clothed with long white hairs. In colour and general facies most like the female of *cruentata* Thoms., but that species has a strongly convex interval that limits the marked subsutural concavity, with much shorter pilose clothing beneath *inter alia*. Type ♂ in Coll. Carter, type ♀ in the South Australian Museum.

Melobasis bimetallica, n. sp.

Elongate oval; head, prothorax, underside, legs and tarsi coppery-bronze (the underside very brilliant); antennae, two basal joints bronze, the rest steel-blue; elytra brilliant golden, glabrous above and below.

Head densely, not coarsely, punctate, glabrous, a smooth spot at middle of base.

Prothorax apex rather strongly bisinuate, base nearly straight, sides widely rounded, anterior angles obtuse, posterior subrectangular; disc canaliculate throughout, widely so on basal half, strongly, not closely, punctate, rugose on sides, a deep oval fovea on each side equidistant from base and side.

Scutellum convex and subcordate.

Elytra slightly wider than prothorax behind the shoulders and two and three quarters times as long, sides lightly sinuate, gradually

narrowed behind, posterior margins finely serrated, apices separately rounded; seriate punctate, suture carinate behind, subsutural area depressed and irregularly punctate; three or four intervals irregularly and feebly convex, series of grouped punctures—not single rows—between these here and there, the punctures becoming quite irregular and much coarser towards sides. Prosternum densely and coarsely, meso- and meta-sternum diffusedly and coarsely, abdomen finely punctate, the last segment with narrow arcuate excision between two short spines.

Dim. 17 × 6 mm.

Hab. Western Australia, Perth (*C. French Coll.*).

A single female example (the type) in the National Museum is possibly nearest to *M. derbyensis* Blackb. In general form, especially of prothorax, it is most like the corresponding sex of *iridescens* Hope. The strongly contrasted colours of prothorax and elytra, the very nitid, glabrous underside and large size are unusual combinations of characters.

Melobasis macleayi, n. sp.

Elongate oval, above peacock-green, pronotum sometimes with golden reflections (especially on lateral margins), elytra with suture narrowly golden, subsutural region blueish or violaceous, underside brilliant purple, tarsi, upperside of legs and antennae green, reverse side coppery.

Head very finely and densely punctate, with short sparse silvery tomentum, eyes large and jutting beyond the width of prothorax at apex.

Prothorax apex subtruncate, base rather strongly bisinuate (middle lobe round the base thence sub-angulately directed backwards), sides nearly straight, whole surface with a fine, dense, transverse punctuation becoming more clearly rugose laterally, a smooth medial line terminating in basal fovea; all angles slightly produced, the posterior acute.

Scutellum very small and circular.

Elytra three times as long as prothorax, lightly compressed behind shoulder, evenly narrowed behind, posterior margins strongly serrated, apices separately rounded; striate-punctate, the series traceable on middle half of elytra, except quite near the suture; seriate punctures round and regular, intervals quite flat, those near suture impunctate, on lateral half the punctures dense, larger and often confluent. Underside glabrous, with dense scale-like punctures, margins of abdominal segments widely impunctate,

apical segment of ♂ with two lateral spines and a short medial tooth, of ♀ medial tooth absent, and apical spines closer.

Dim. 7–11 × 2½–4 mm.

Hab. QUEENSLAND, Rockhampton, Bowen, Cairns, Cooktown, etc.

Three examples (including types) in Australian Museum, Sydney, seven in the Macleay Museum, two in National Museum, three in Simson Coll. (South Australian Museum), one in Coll. Lea, two in the Queensland Museum and one in Coll. Illidge. The species is superficially like *M. suturalis* Macl. from New Guinea, but that species has a sparsely punctate pronotum with rounded sides, a large transversely oval scutellum, elytra seriate-punctate throughout, underside blue *inter alia.* Var. (in Macleay Museum) has the head and pronotum largely coppery, the disc of elytra largely violaceous.

Melobasis illidgei, n. sp.

Ovate, head coppery (mouth greenish) albo-pilose, pronotum coppery-black with cyaneous reflections, elytra black with seven fiery coppery markings as follows: two humeral, an oblong sutural one behind scutellum, two wide medial—extending neither to sides nor suture, and two triangular preapical markings; underside and legs dark violaceous, the middle parts of underside coppery, densely clad with fine silvery hair, tarsi green. (In the ♀ type the elytral markings greenish.)

Head not wider than prothorax at base, eyes large.

Prothorax apex and base subtruncate, the latter very feebly sinuate, sides nearly straight, narrowing in front and lightly arcuate behind, disc with clear round punctures, rather dense on middle—very dense and transverse at sides, a smooth medial line terminating in a basal fovea.

Scutellum small and transverse.

Elytra scarcely enlarged at shoulders, rather widely arcuate behind—posterior margins strongly serrate, each apex rounded separately; suture raised on apical half, disc with two or three wide, feebly convex subcostae bounded by confusedly punctate striae, otherwise quite flat and irregularly punctate, the punctures fine near suture, coarser laterally. Underside densely punctate, but sculpture largely concealed by hairy clothing; apical segment of abdomen carinate—the carina slightly produced behind forming a short lobe (rather than tooth) between two strong spines.

Dim. 11–12 × 4–5 mm.

Hab. CENTRAL QUEENSLAND, Cooroorah (*R. Illidge*); Longreach (*A. M. Lea*).

Three examples—two ♂ sent by my friend the veteran Queensland naturalist after whom I name it, the ♀ type in Coll. Lea, show a species near *M. monticola* Blackb. and *M. sexplagiata* C. and G. From the former it differs in the larger coppery markings and totally different sculpture, the elytra of Blackburn's species being rather regularly punctate-striate between raised intervals. In *M. sexplagiata* the ground-colour is more decidedly blue, the four hinder markings taking the form of parallel fasciae. From both species the above differs widely in its strongly pilose under-surface, its two allies being glabrous, or nearly so.

Melobasis septem-plagiata, n. sp.

Elongate, subpisciform in ♂, convex, head and pronotum dark bronze, tinged with steel-blue (sometimes wholly blue), rather thickly clothed (the latter at sides only) with long white hairs, elytra coppery-bronze, violaceous towards and blue at extreme apex with seven steel-blue markings as follows:—the first longitudinal at suture behind scutellum common to both elytra, one on each shoulder, in general obliquely directed inward and continued below the humeri along margin, another pair triangular forming a short medial fascia, its base resting on the 2nd interval, its apex halfway across elytron or extending to it; the third pair preapical, triangular, situated between the 2nd and 4th intervals, scutellum fiery coppery, semicircular; antennae, tarsi and parts of tibiae steel-blue, under-side dark coppery, densely clothed with white recumbent hair.

Head, eyes moderately prominent, a slight depression at middle of base.

Prothorax lightly bisinuate at apex and base, sides slightly rounded, finely punctate at middle, densely and rugosely at sides, a few smooth spaces indicated along medial line, a small basal fovea near scutellum.

Elytra of same width as prothorax at base and three times as long, widest at shoulders, thence gently narrowing to near apex—this sinuously produced (sublobate) in ♂ strongly serrated on margins; each apex separately rounded; seriate punctate in part, the posterior suture carinate and two or three intervals strongly convex; of these the apparent 2nd interval is raised throughout—the sutural region between these forming a nearly smooth depression, the post-scutellary area depressed between the short scutellary costae, finely irregularly punctate; beyond the 2nd interval other feebly

raised lines and between these some finely rugose-reticulate punctures becoming merged laterally in a fine, irregular, transverse striolation. On underside the sculpture obscured by pilose clothing. Apical segment of ♂ truncate between two spines, in ♀ with narrow arcuate excision.

Dim. 12–13 × 4 (vix) mm.

Hab. Western Australia, Cue (*H. W. Brown*).

Eight examples—Australian Museum, two, South Australian Museum, four, Coll. Carter, two show a species that suggests *M. nobilitata* Thoms., but is more elongate and cylindric with an inverse colour scheme—blue markings on copper ground instead of gold on blue. The produced apex distinguishes it from *M. formosa* and other patterned species—a character chiefly conspicuous in ♂ examples. In general facies it is much like *M. meyricki* Blackb., which, however, lacks the elytral markings, the strong pilose underside and head, the apices less pisciform, together with finer elytral sculpture. The elytral maculae and blue tinge on pronotum are sometimes but faintly marked. Types in Australian Museum.

Melobasis dives, n. sp.

Elongate oval, head and prothorax bright golden, the first with green reflections, the second with two clearly defined steel-blue vittae, slightly diverging towards the base; elytra bright golden with the following dark blue markings :—two vittae continuous with those on pronotum, one on each side of and near the suture, extending half the length of elytra; a sinuous, postmedial fascia not reaching the sides, at the suture narrowing, spreading to the apex backwards and to a less degree forwards; also a vague sagittate mark between the fascia and apex. Underside, legs, tarsi and antennae dark blue.

Head densely, contiguously, punctate, sparsely tomentose.

Prothorax rather strongly bisinuate at apex and base, anterior medial lobe prominent, sides evenly and moderately rounded, anterior angles obtuse, posterior acute.

Scutellum transverse, oval, central part occupied by a large puncture.

Elytra of same width as prothorax at base and two and a half times as long; lightly compressed before the middle, arcuately narrowed behind, posterior margins strongly serrated, each apex separately rounded; suture slightly carinate behind, a few longitudinal lines feebly raised above the rest of surface, about two rather

undefined lines of fine seriate punctures on each elytron, visible on vittate area, the blue parts generally smooth or minutely punctate, the golden areas strongly, subconfluently, punctured and transversely rugose laterally; pro-, meso- and meta-sternum coarsely punctate, the punctures dense on the last two, more diffuse on the prosternum, abdomen much more finely punctate and almost glabrous, last segment with arcuate excision limited by two short teeth.

Dim. 15 × 5 mm.

Hab. NORTHERN TERRITORY, Roper River.

A single female example (type) in the National Museum, Melbourne, is the most beautifully marked species in the genus, the steel-blue vittae and fascia being clearly defined on the brilliant golden ground-colour, the post-fascial marking only being obscure.

Melobasis iridicolor, n. sp.

Elongate oval, head golden or green, sparsely pubescent, pronotum blue with two ill-defined purple vittae and some golden reflections, scutellum blue, elytra varicoloured—the scutellary region golden green, shoulders and margins (widely) blue, sutural region purple, prosternum and femora golden, rest of underside, legs and antennae brilliant metallic green, tarsi chiefly blue.

Head very finely and densely punctate, eyes large and prominent.

Prothorax apex subtruncate, base bisinuate, sides nearly straight, gently narrowing from base to apex, all angles a little produced and acute, densely punctate with a tendency to transverse striolation, a smooth medial line terminating in a small basal fovea.

Scutellum very small and bead-like.

Elytra clearly seriate-punctate throughout, the seriate punctures round and regular, intervals flat, some irregular punctures on sutural, humeral and lateral regions, the humeral area finely rugose.

Prosternum finely and densely, meso- and meta-sternum finely and sparsely punctate, abdomen with fine scratch-like punctures—the margins of segments smooth. Apical segment in ♂ truncate between two sharp spines, in ♀ narrowly excised and bispinose.

Dim. 11 × 4 mm.

Hab. NORTHERN TERRITORY, Darwin (*H. P. Dodd. in Coll. Carter* and *Lea*); Cairns (*Coll. Lea*).

Three examples examined, are very like *macleayi* in form, but besides the strong colour distinction, the clearly seriate-punctate elytra and finer system of puncturation above and below show specific difference.

No two of the examples are quite alike in colour, though in each the colours are brilliant and elusive, the ♀ type from Darwin (Coll. Lea) has the head golden green, pronotum purple and blue-green, and eltyra chiefly purple. Type ♂ in Coll. Carter.

Melobasis abnormis, n. sp.

Convex, widely ovate, nitid bronze-black above, nitid dark bronze below, head and breast densely, pronotum and abdomen sparsely albo-pilose.

Head rather coarsely punctate on vertex, with a smooth longitudinal sulcus extending from base to about one-third length of eyes, remaining area concealed by dense hair.

Prothorax apex arcuate, anterior angles acutely produced, base lightly bisinuate, posterior angles rectangular, sides moderately rounded, widest behind middle, thence arcuately narrowed in front, more sharply behind; medial line more or less impressed throughout, terminating behind in a fovea, a large longitudinal depression near each side, medial region very finely and sparsely punctate, lateral punctures coarser, extreme sides rugose and pilose.

Scutellum rather square, lightly rounded behind.

Elytra slightly wider than prothorax at base, subparallel to halfway, thence obliquely narrowed to a fine apex, apices triangular each forming a blunt tooth, margins of oblique part coarsely serrate; surface irregularly reticulate-rugose-punctate, some incomplete costae starting from base, one nearer suture erratically undulate in middle, sharply defined near apex, a second preapical costa for a short distance parallel to former, the greater part of surface with irregularly reticulate ridges enclosing some sparsely punctate depressions, suture carinate on basal half. Pro-, meso- and metasternum with coarse round punctures, those on abdomen coarse and elongate—leading to confluence on basal segments, fine at middle; last segment with narrowly arcuate excision between short spines.

Dim. 14 × 5-5 mm.

Hab. West Australia, Israelite Bay (*French Coll. Melbourne Mus.*): Australia (*Fry Coll. British Mus.*).

Two examples, both ♀, examined of this singular species—easily distinguished by the combination of dark colour, wide form and unusual sculpture—the last (viewed as a whole) showing longitudinal arrangement of its intervals. Type in National Museum, Melbourne.

Melobasis pictlcollis, n. sp.

Elongate oval, glabrous, brilliant emerald green above and below, antennae and tarsi blue, pronotum with wide violaceous vitta on each side of middle.

Head densely, evenly punctate, eyes prominent, extending beyond width of pronotal apex.

Prothorax apex and base moderately bisinuate, sides nearly straight, or very lightly arcuate throughout; a smooth medial line, often with a smooth spot on each side on front half; punctures fine and sparse near middle, dense and transverse near sides.

Scutellum widely oval and smooth.

Elytra lightly compressed near middle, rather widely and separately rounded at apex, apical margins coarsely serrate; the subsutural interval subcostate, a second raised interval showing near base and apex; sutural area finely, irregularly, sparsely punctate, outside this area about four lines of seriate punctures readily discerned, the two nearer middle showing minute duplicated punctures, the lateral area—especially on apical half—showing close transverse ridges. Underside glabrous, densely and finely punctate, the punctures deeper and closer on breast than on abdomen.

Dim. 8–10 × 3–3–5 mm.

Hab. VICTORIA, Mount Macedon (*The Author*); New South Wales, Maitland to Moruya; Tasmania (*Kerremans Coll. Brit. Mus.*).

A common species that has been confused with *simplex* Germ., but clearly differs by the pronotum not abruptly narrowed behind and in being much less finely and densely sculptured, the elytral punctures in *simplex* being very irregular.

Var. Pronotum without violet vittae.

In this case separated from *occidentalis* by colour and sculpture (elytral punctures smaller), and from *innocua* Thoms. by the straight-sided and less strongly punctate pronotum *inter alia.* Types in Coll. Carter.

Melobasis occidentalis, n. sp.

Above obscure bronzy green, margins of elytra—especially near apex—fiery copper red; underside more or less bronze-green or bronze, antennae and tarsi steel-blue.

Head densely, rather finely punctate.

Prothorax apex strongly, base feebly bisinuate, anterior angles subacute, posterior subrectangular (as seen from above), sides

nearly straight—feebly arched in middle, lightly narrowed behind; disc lightly punctate in middle with some smooth spaces, more densely punctate elsewhere, with a variable tendency to transverse arrangement near sides; the punctures over the greater part round and increasing in size outwards; a small pro-scutellary fovea.

Scutellum small, subcircular.

Elytra narrowly oval, strongly serrate on hind margins, apices separately rounded; irregularly seriate-punctate, the suture subcarinate behind and two or three intervals variably convex, the punctures larger, with some transverse ridges, towards sides. Underside nitid, very scantily pilose.

Dim. 8–9 × 3–3·5 mm.

Hab. West Australia, Yallingup (*R. E. Turner*); Swan R. (*A. M. Lea* and *H. W. Brown*); Geraldton (*A. H. Lea*).

Several examples in British Museum and in Coll. Carter show a small species of variable colour, *i. e.* the amount or absence of coppery margins, the ground-colour varying in the prevalence of green or bronze. In sculpture it is near *obscurella* Thoms., but the pronotum is less rounded, more sparsely and finely punctate. From the *simplex* group it is separated by the pronotum less narrowed behind—its punctures evidently more sparse and rounded. As in many other species there is some variation of colour and even of sculpture, the seriate punctures being more clearly defined in the ♀ type than in the ♂, while the convexity of elytral intervals varies with individuals. Types in British Museum.

Melobasis caudata, n. sp.

Elongate, subconical, apex pisciform, head and pronotum bronze suffused with blue, elytra coppery bronze with suture and apex, antennae and tarsi steel-blue; underside coppery bronze with sparse tomemtum.

Head rather coarsely punctate and strongly pilose, narrower than base of prothorax.

Prothorax convex, apex strongly, base lightly bisinuate, sides nearly straight, gently narrowed (in a feeble curve) from base to apex, anterior angles produced and acute, posterior subrectangular, a smooth medial line sometimes evident (as in ♂ type), disc moderately punctate, the punctures round, small near middle, larger and crowded at sides, with less evident transverse sculpture than usual, a smooth foveate depression near scutellum.

Scutellum subquadrate, moderately large.

Elytra basal half subcylindric, sinuously narrowing and elongate at apex, posterior margins strongly serrated, apices rather widely separated and rounded, transversely depressed near shoulders, a triangular depression behind scutellum, a narrow subsutural concavity, suture lightly carinate behind; substriate punctate, with a few rows of small, crowded punctures between lightly raised intervals, the external half of elytra closely and irregularly punctate with some transverse rugosity towards the humeral region, punctures evanescent near apex. Underside densely punctate, sternum and sides of abdomen rather strongly albo-pilose.

Dim. 12–13 × 3·5–4 mm.

Hab. West Australia, Cue and Ankertell (*H. W. Brown*).

Several examples taken by Mr. Brown were at first misdetermined by me as *meyricki* Blackb., which it resembles in form, but which is metallic green above with violaceous apex and with a much more strongly punctate elytra and a more evident seriate arrangement. The blue coloration extends rather widely at apex, fills the sutural hollow and bifurcates at the post-scutellary depressions; besides showing on the humeral callus and here and there on margins. Types in Coll. Carter.

Melobasis regalis, n. sp.

Elongate, subparallel, head and underside coppery bronze, densely clad with long, pale, recumbent hair; pronotum varicoloured, a wide medial line golden; on each side of this a dark blue triangular area, narrowing to apex, sides widely greenish-coppery, tinged golden at their junction with the blue area; elytra blue (violaceous near apex) with the scutellum and seven markings golden as follows:—a wide post-scutellary vitta bifurcating behind to meet the two subfasciate medial plaga, two elongate, slightly oblique markings behind the humeral callus, produced horizontally along the base, and a triangular preapical pair.

Head densely covered with a longitudinal system of punctures (partly obscured by hair), a slight depression at middle of base, eyes a little converging behind.

Prothorax apex strongly, base lightly bisinuate, sides lightly rounded, subsinuate behind; all angles produced and acute, medial channel deeply cut throughout and ovally widening near apex, the medial golden area with sparse, large round punctures on basal half, with denser, smaller punctures on apical half, the blue area sparsely punctate, lateral area coarsely, irregularly rugose punctate.

Scutellum elongate oval, smooth.

Elytra subparallel for the third of length, thence rather obliquely narrowed, subapical margins and apex serrate, the latter separately rounded; subsutural concavity well marked and bounded by a strongly costate interval; this area more lightly punctured than the rest; three shorter equally spaced, lightly convex intervals traceable; an irregular system of coarse punctures over the greater part of elytra—without defined longitudinal arrangement; becoming strongly transversely rugose towards margins and shoulders. Underside punctate—the punctures obscured by the dense clothing, this extending to legs—the apical segment of abdomen truncate between two short spines.

Dim. 15 × 5 mm.

Hab. West Australia, Albany (*Brewer*).

A single male example sent from the British Museum is in colour near *M. nobilitata* Thoms., but in form near the *nervosa* group, though presenting only a single marked costa on each elytra. This beautiful species may be distinguished from the other "septem-plagiate" species by its combination of brilliant colour, strongly channelled pronotum, the well-marked subsutural concavity, the coarsely punctured upper surface and the strongly pilose underside. Type in the British Museum.

Melobasis fasciata, n. sp.

Moderately convex, widely ovate. Head green or blue, pronotum vari-coloured, generally blue in middle, green or purplish at sides. Elytra brilliant blue or violet, with basal, medial and preapical fasciae; the first with a triangular extension backwards along the suture, the second interrupted at suture, enlarged at sides, generally meeting basal fascia at extreme margin; the third interrupted at suture and not quite reaching sides; underside green or blue. Legs and antennae deep blue or violet.

Head densely punctate, wider at eyes than apex of pronotum.

Prothorax apex very lightly bisinuate, base nearly straight, sides narrowed in a gentle curve from base to apex, disc rather lightly, not closely punctate—the punctures coarser and denser on sides—a smooth medial line.

Scutellum transversely oval, impunctate.

Elytra not very convex, widely oval, hind margins coarsely serrate; apices separately and rather widely rounded; intervals scarcely elevated except the subsutural and a short scutellary one; these two lightly convex but scarcely costate. Pro- and meta-

sternum coarsely punctate, abdomen lightly so; apical segment in male strongly spinose, the female with an oval excavation between two shorter spines.

Dim. 10–13 × 4–5 mm.

Hab. QUEENSLAND, NEW SOUTH WALES and VICTORIA.

This is the species hitherto incorrectly labelled in Australian collections as *sexplagiata* C. and G. (which from a study of the figure and specimens so named in the British Museum is probably identical with *pyritosa* Hope). Unfortunately I have not been able to find the type of *sexplagiata* C. and G. *Fasciata* can only be confused with *superba* C. and G., which is clearly separated by the presence of three well-raised costae on the elytra—*sexplagiata* C. and G. (*pyritosa* Hope is distinguished by its fiery ground-colour and the extension of the basal coppery marking backward from the shoulder).

Melobasis formosa, n. sp.

Oblong; head, pronotum and scutellum nitid, the first strongly albo-pilose, the last two tending to golden bronze, elytra purple, with seven plagae green or golden; two subhumeral wedge-shaped, a little obliquely pointing backwards and inwards; two medial subfasciate interrupted (sometimes widely) at suture and sides; two subapical oblique (sometimes small or subobsolete); and a small elongate sutural spot behind scutellum; underside brilliant golden bronze, subglabrous; antennae and tarsi golden green.

Head narrower than prothorax at base, narrowly channelled at vertex, strongly, not densely punctate at base.

Prothorax lightly convex, apex and base feebly sinuate; a little produced at angles—the apical more strongly so—sides lightly rounded, widest at middle; disc clearly, not coarsely, punctate, punctures close at sides, sparser at middle, medial line and a small space on each side of it more or less laevigate.

Scutellum subcircular, depressed in middle.

Elytra scarcely enlarged at shoulders, subparallel on basal half, moderately narrowed towards apex, margins strongly serrated on apical half, apices separately rounded, suture raised behind; disc with subsutural (sometimes one other) interval feebly raised; intervals otherwise flat, clearly and closely punctate, with little longitudinal arrangement of punctures, except by indefinite smooth intervals on green plagae; punctures becoming close and transverse at sides; sternal area closely and coarsely punctate, abdomen with light striolate-punctate surface, feebly pilose at sides; apical

segment of male truncate between two very short teeth, of female with rather wide oval excision without teeth.

Dim. 12–13 × 4½–5 mm.

Hab. Western Australia, Southern Cross and Cue (*H. W. Brown*); South Australia, Quorn (*A. H. Elston*).

This is the species taken by Mr. Brown in some quantity and generously distributed amongst Australian collections, which I misdetermined as *M. superba* C. and G. previous to my visit to England. It is, however, distinct from that species in colour, form and sculpture. Type in South Australian Museum.

The following are the species of which I have examined the types.

porteri Hope.
pyritosa Hope.
serratula Hope.
verna Hope.
cupriceps Kirby.
cuprifera C and G.
gloriosa C. and G.
lathami C. and G.
propinqua C. and G.
superba C. and G.
simplex Germ. (vide supra).
apicalis Macl.
azureipennis Macl.
costata Macl.
lauta Macl.
suturalis Macl.
costata Saund.
cupreo-vittata Saund.
goryi Saund.
igniceps Saund.
laeta Saund.
metallifera Saund.
obscura Saund.
rubro-marginata Saund.
viridiceps Saund.
viridis Saund.
andersoni Blackb.
beltanensis Blackb.
bicolor Blackb.
derbyensis Blackb.
elderi Blackb.
interstitialis Blackb.
intricata Blackb.
meyricki Blackb.
monticola Blackb.
pretiosa Blackb.
pulchra Blackb.
puncticollis Blackb.
rothei Blackb.
rotundicollis Blackb.
semistriata Blackb.
semisuturalis Blackb.
speciosa Blackb.
sordida Blackb.
soror Blackb.
subcyanea Blackb.
thomsoni Blackb.
thoracica Blackb.
vittata Blackb.
acuta Kerr.
aenea Kerr.
amabilis Kerr.
auro-notata Kerr.
blackburni Kerr.
callichloris Kerr.
coeruleiventris Kerr.
concolor Kerr.
costipennis Kerr.
cupricollis Kerr.
cuprina Kerr.

fairmairei Kerr.
ignicauda Kerr.
ignipicta Kerr.
incerta Kerr.
melanura Kerr.
miranda Kerr.
nigrita Kerr.
nitidiventris Kerr.
terminata Ker.
vicina Kerr.
violacea Kerr.
viridicollis Kerr.
viridiventris Kerr.

I append here a few notes on genera, often confused with *Melobasis*, viz. *Briseis*, *Diceropygus* and *Melanophila*, the last two of which were omitted from Masters' Catalogue.

The distinctions between *Briseis* and *Melobasis* are small but convenient. In *Briseis* the form is more cylindro-conical, with a peculiar character of the anterior margin of the prosternum which is straight between two round tubercles (absent from *Melobasis*). Two new species are added below.

The described species of *Briseis* may be tabulated as follows :—

A. Colour greenish (or green-black), elytral intervals convex.
  B. pronotum with wide medial sulcus.
  conica C. and G., var. *acuminata* Kerr.
  B. B. Pronotum without medial sulcus.
    C. 12–15 mm. long, clypeus arcuately concave . *curta* Kerr.
    C. C. 18–19 mm. long, clypeus strongly bilobed.
    elongata, n. sp.
A. A. Colour brassy copper, elytral intervals flat . *cuprea*, n. sp.

Briseis cuprea, n. sp.

Navicular, glabrous, brassy coppery above and below, apex of elytra, tarsi and antennae blue, labrum green.

Head rather closely punctate—the punctures longitudinal, lightly canaliculate throughout, eyes large and prominent.

Prothorax apex subtruncate, base bisinuate, sides straight, narrowing from base to apex, all angles a little produced, the posterior acute, medial line only indicated by an elongate basal fovea; very finely and sparsely punctate on disc, more strongly and densely on sides.

Scutellum very small, impressed at middle.

Elytra moderately enlarged behind shoulder, thence narrowing to a fine apex, extreme tips separately rounded, posterior margins and apex coarsely serrate; surface finely seriate-punctate, intervals generally flat and smooth, the 2nd and 4th alone feebly raised, sutural region with some irregular punctures.

Prosternum closely, meso- and meta-sternum sparsely punctate; abdomen with longitudinal (scratch-like) punctures, sparse on basal, dense on apical segment, the last truncate between two short teeth.

Dim. 13 × 4 mm.

Hab. QUEENSLAND, Cairns (*F. P. Dodd*), in South Australian Museum.

The brilliant coppery surface and non-striate elytra readily distinguishes this species from the only three described species. Type, unique, in the South Australian Museum.

Briseis elongata, n. sp.

Elongate cylindro-elliptic; dark metallic green, underside concolorous but more brilliant, apex of elytra and of abdomen blue, head golden green, antennae with two basal joints green, the rest —and tarsi—blue.

Head nearly glabrous, densely punctate, channelled at vertex, clypeus strongly bilobed, the lobes rounded in front and separated by wide triangular excision.

Prothorax bisinuate at apex and base, sides nearly straight, gently, obliquely converging from base to apex, feebly sinuately widened behind, all angles produced, the anterior widely, the posterior sharply acute, a smooth medial line terminating behind in a punctiform fovea; sparsely and finely punctate near middle, densely and more coarsely at sides.

Scutellum small, scutiform, smooth.

Elytra lightly enlarged near base, then parallel to apical third, finely attenuated behind, apices separately rounded; posterior margins and apices very coarsely serrated; striate-punctate, each elytron with nine striae containing fine, close punctures, obsolescent towards apex and forming double rows near base, the subsutural stria containing a double row of punctures throughout, all intervals nitid and impunctate. Underside densely and finely punctate—the punctures larger, but not coarse on breast—with short, sparse, pale pubescence. Apical segment of ♂ truncate between two parallel spines, of ♀ with narrow, arcuate excision between two diverging spines.

Dim. 18–19 × 5½–6 mm.

Hab. QUEENSLAND, Marmor (*H. W. Brown*); Rockhampton (*Macleay Museum*). Eight examples, including the sexes, have been examined.

Apparently the commonest species of the genus, it is easily distinguished from *B. curta* Kerr. by (1) much larger and less ovate form, (2) the bilobed clypeus (arcuate concave in *curta*), (3) finer sculpture of upper surface—smaller punctures, less convex elytral intervals, besides the brighter colour, especially of head and underside. From *B. conica* C. and G. it is further separated by the absence of the characteristic pronotal sulcus. Types in Coll. Carter.

B. acuminata Kerr. I can only consider this as a variety of *B. conica* C. and G. The whole description of the former applies to the latter, except that in Kerremans' description the pronotum is said to be " vaguement sillonné au milieu " instead of with " un grand enfoncement au milieu " as in *conica*. I have an example which *is* thus vaguely furrowed, but is otherwise indistinguishable from typical specimens of *conica*. The author's own note of distinction is " Se distingué surtout du *Br. conica* Cast. et Gory par l'éxtremité des élytres très acuminée et par l'écusson concoloré." *Br. conica* is, however, strongly acuminate behind, while the colour of the scutellum varies from purple to green-black. (This synonymy confirmed by comparison of types.—H. J. C.)

Diceropygus maculatus Deyr. Specimens from Darwin (N.T.) exactly correspond with the description of this species (originally from Key Is.). The " coppery halo " said to surround the medial maculae is possibly exaggerated in the figure given by the author. There is some indication of this " halo " in one example of the four under examination (three in the National Museum, Melbourne, one in my own collection).

N.B.—The genus *Diceropygus* appears to be distinguished from *Melobasis* only by its large scutellum and robust abdominal spines. *D. maculatus* Deyr. and *D. viridiauratus* Deyr. (from Woodlark Is.), which I possess, have the last abdominal segment finely carinate in middle—a character unnoticed in the generic and specific diagnosis, but I cannot find in either of these species the " trou profond creusé dans le pygidium "—a character which M. Thery has noted in *D. scutatus* and which he suggests may be generic.*

Thomson has described one species, *D. australis*, from Australia, which I have determined for an example in the Queensland Museum from Cape York. The other six

* Mem. Soc. Ent. Belg., 1911, p. 22.

species are chiefly from Papua and the adjacent islands, one from New Caledonia.

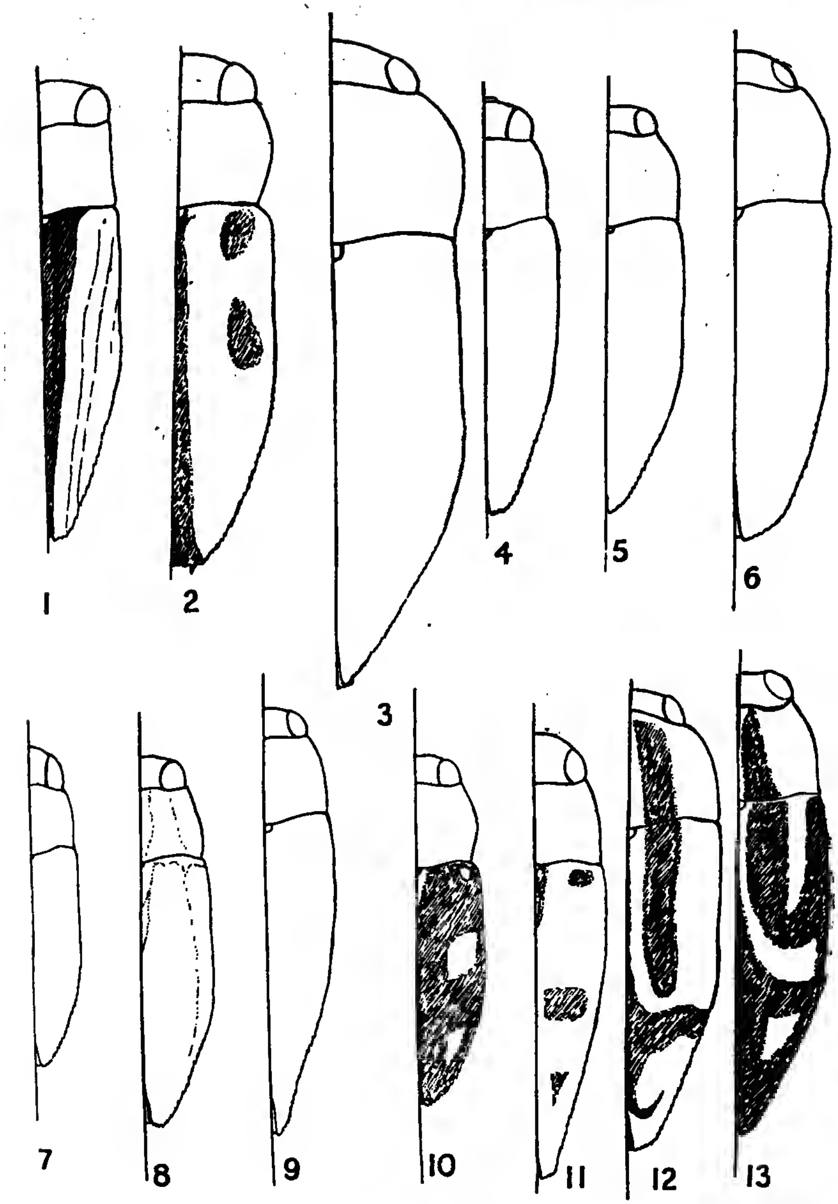
Melanophila Eschscholtz, another genus omitted from Masters' Catalogue, is nearer *Anilara* than *Melobasis*. It is separated from the former by the bisinuate base of pronotum, greater size, elongate form, etc., and from the latter by its depressed form and finely punctured surface—the elytra completely devoid of any linear arrangement in its sculpture. Two names are recorded by Kerremans (Gen. Ins., p. 164) as from Australia: *M. laticeps* Kerr. and *M. australasiae* Kerr., but they appear to me to apply to the same species, a species that I find in many collections from Sydney, Blue Mountains, Dorrigo, Tambourine Mountain, Q., and Gayndah, Q.

The chief differences in the descriptions of the two species apply to colour; *M. laticeps* (first described as a *Melobasis*) being said to be "Vert sombre en dessus. . . . Dessous vert brillant," and *M. australasiae* as "capite thoraceque nitidis purpureis . . . elytris obscure violaceis, paulo viridi micantibus . . . subtus medio pedibusque viridibus, ad latera purpurea."

In the long series before me—certainly conspecific—some examples correspond to the one and some to the other. The localities given for *australasiae* are Sydney and Gayndah; for *laticeps*, Australia. Further, an examination of the type of *Anthaxia cupripes* Macl. convinces me that this also is the same species, though the two examples in the Australian Museum are both darker than fresh examples, and are without the coppery margins to the elytra. Specimens from Victoria (Mr. E. Wilson) and the Blue Mountains (Dr. Ferguson) correspond with these. As this may be due to immersion in spirit or more probably mere variation I have little hesitation in stating the following synonymy:

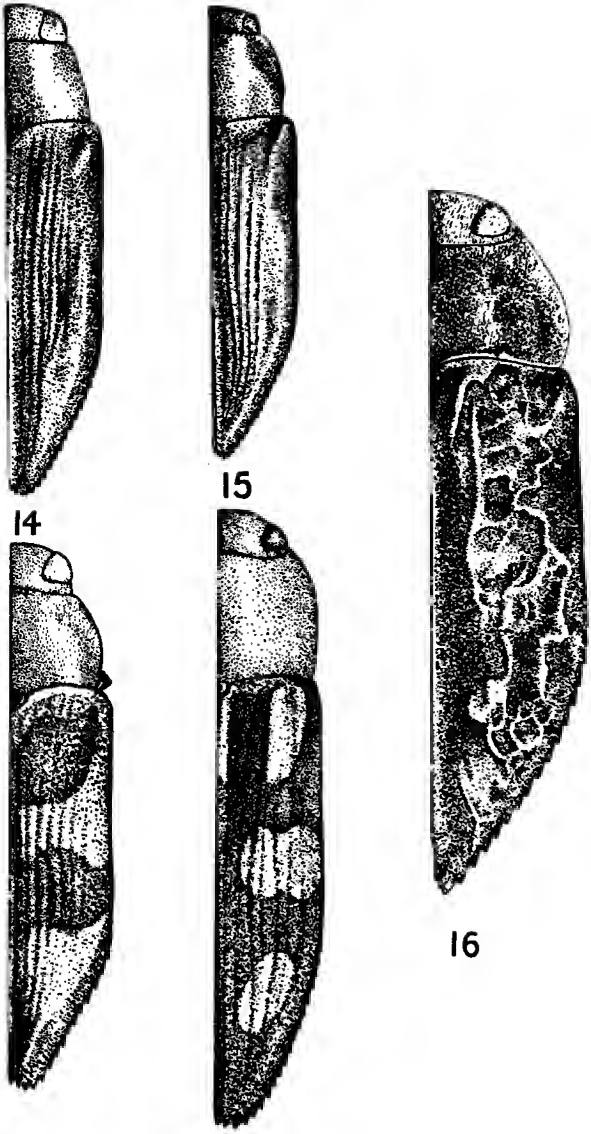
Melanophila (*Anthaxia*) *cupripes* Macl. = *M.* (*Melobasis*) *laticeps* Kerr. = *M. australasiae* Kerr.
= (*Neocuris*) *dilataticollis* Blackb.

(This synonymy confirmed by examination of types, 26/6/22, H. J. C. The type of *Neocuris dilataticollis* being a small example 6 mm. long.)



Vaus & Crampton.

MELOBASIDAE.



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Vaus & Crampton.

MELOBASIDAE.

EXPLANATION OF PLATES.

PLATE I.

FIG. 1. *Melobasis vertebralis.*
2. „ *quadrinotata.*
3. „ *robusta.*
4. „ *subconica.*
5. „ *uniformis.*
6. „ *bimetallica.*
7. „ *macleayi.*
8. „ *iridicolor.*
9. „ *caudata.*
10. „ *illidgei.*
11. „ *septem-plagiata.*
12. „ *dives.*
13. „ *regalis.*

PLATE II.

FIG. 14. *Melobasis picticollis.*
15. „ *occidentalis.*
16. „ *abnormis.*
17. „ *fasciata.*
18. „ *formosa.*

III. *Description of the Pupal Shell of* Lachnochnema bibulus Fab. By G. T. Bethune-Baker, F.L.S., F.Z.S.

Plate III.

[Read November 15th, 1922.]

I am enabled to give these notes through the kindness of Prof. Poulton. The material was received by him from Mr Lamborn, whose observations on the habits of the larvae of many Lycaenidae and other groups have been of great value to all workers. Our gratitude is due to both Prof. Poulton and Mr. Lamborn, whose enthusiasm inspired the late C. O. Farquharson to carry out breeding experiments which have brought to light the early stages of so many Rhopalocera, including the extraordinary larva of *Teratoneura isabellae.*

Lachnochnema bibulus.

Description of Pupae, 692*a*, 692*b*, 692*c*.

These pupae seem to have Theclid affinities, and in coloration and form the late Dr. Chapman told me that they reminded him a good deal of *Strymon w. album.* This, however, may have been due to the piebald markings on the thorax, which occur in both species.

L. bibulus is shorter and thicker as well as rather smaller, it is also (a very important character) hairless—glabrous—and has dorsal and subdorsal rows of short blunt spines, a feature that has not been recorded as occurring in European Lycaenidae. The pupae examined are empty cases and are therefore variously distorted, and their colour values are probably not the same as when alive.

Though the pupae are hairless the larva, according to a skin that was with one specimen, is hairy, having hairs of two or more tints, of which the darker (blackish) are simple, the paler (subochreous) are spiculated; there are many that are ·6 mm. in length. Their bases are smooth (not stellate) and have apparently fluted sides—a Theclid character.

These notes are from a cast skin, the position of which

has been disturbed, so they must not be asserted with complete confidence.

The pupae cases are gummed on card, one on a leaf, and therefore cannot be examined from all aspects. They are about 8 mm. long, and 3·5 mm. broad across the 4th abdominal segment at the broadest point; they have a fairly marked waist, if I may use the word, the thorax being decidedly narrower than the abdomen. Ventrally the abdomen is only about 2 to 2·4 mm. of the full length, of this the 5th abdominal segment is ·4 mm., and is followed directly by an oval plate 1·4 mm. long and 1·7 mm. broad; it is of a brown colour and forms the 9th and 10th segments, which are almost indistinguishable. Then the *dorsal* portions of the 6th to 8th abdominal segments follow; these (segments) end on each side, between the 5th abdominal segment and the anal plate, *i.e.* the 9th and 10th segments (which are tucked far under), without reaching the ventral line. This occurs in one specimen, in another the 6th segment has a decided tubercle at the ventral margin on each side and a narrow flat strip across the venter between them; in this specimen the anal plate has also two tubercles towards its ventral margin: in the specimen first described it is nearly flat with an indefinite transverse central depression; in both cases it is well armed with minute brown cremastral hooks (Plate III, fig. 1).

The three pupae vary in tint, one is rather darker and another rather paler than the third; the darkest has the abdomen brown or greyish brown, the thorax being the same except for a large white patch on the mesothorax in front of the wing base, nearly 2 mm. across by 1·5 mm. lengthwise. It is almost quadrangular with several small branches; the nose spines are also white; the wings are pale ochreous with brownish lines forming a network of cross lines which merge towards the hind margin into a sort of clouding.

The palest pupa case has the abdomen pale ochreous, the thorax white (except a patch around the dorsal spine and forwards, and a small patch outside this and three little areas on the angles of the mesothorax, on each side); there is also a black dot at the mandibular points.

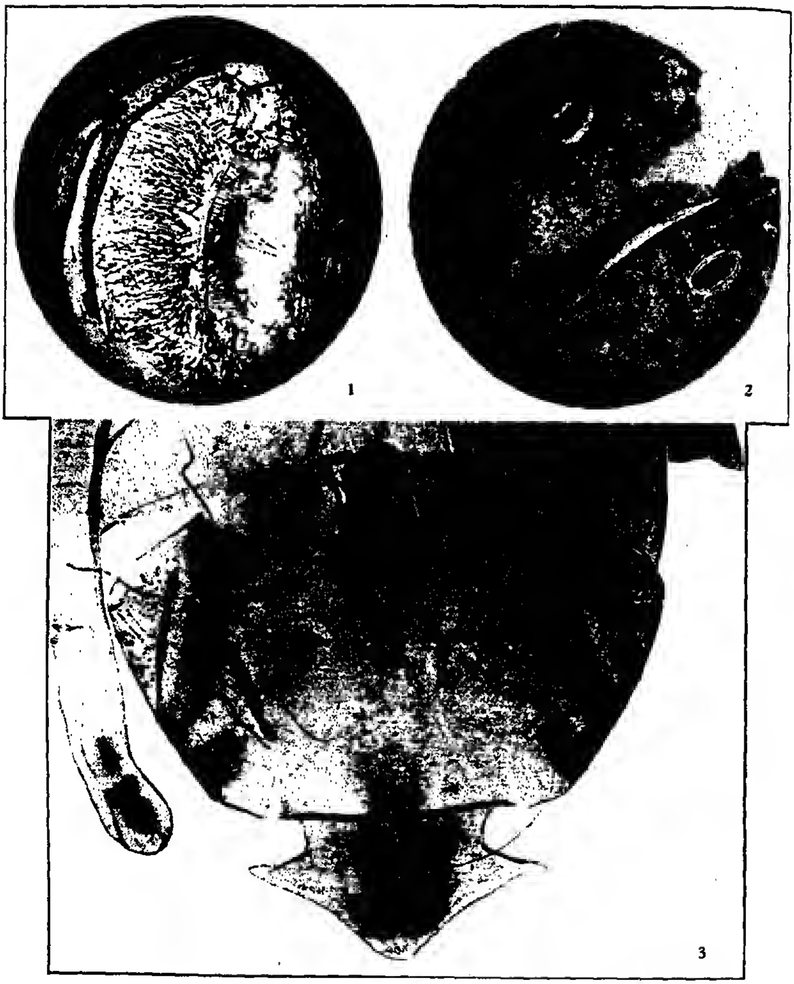
The dehiscence is of the usual *Lycaenid* character. The head, antennae and eyes, etc., separating from the thorax and wings, but remaining adherent at the tips of the

antennae and maxillae; the thorax splitting dorsally and separating from the abdomen except at the hind margins of the wings ventrally. No dorsal head piece was visible, but it should exist; the 5th and 6th abdominal incision open, whether others do so or not on dehiscence the specimens do not show.

The head is large for the size of the pupa, being 2 mm. across by 1·5 long; it faces ventrally absolutely; the labrum is large. The front legs are large, reaching from the antennae to the maxillae in a rather broad plate, this is a character of all the Lycaenidae. There seems to be a dorsal mesothoracic spine, one at each wing base, and some rough points behind this. There is also a prothoracic spine on each side; the thorax, wings, and other appendages are otherwise smooth; the abdomen, on the contrary, is rough and wrinkled. There is a dorsal ridge, as shown by a raised line not equally well marked in all specimens; in one it takes the shape of a small slight nodule near the posterior margin of each segment. These might perhaps be taken as examples of general roughnesses and rugosities; not so, however, with the subdorsal spines on the 2nd to the 6th abdominal segments, which are marked elevations, longer longitudinally than transversely and apparently in the same positions as the spines in Vanessid pupae. The spiracles (Plate III, fig. 2) are raised, paler in colour, and are rather narrow ellipses with the long axis transverse; being pale and raised they are somewhat conspicuous. Some minute sculpturing shows over both the dark and white portions of the marbling (the white parts being the more elevated areas of the irregular surface) as very many minute dark brown spots, each with a shining diamond-like central point. These spots are very small, the spaces between them being about equal to their own width, which is about ·012 mm. They appear to be minute pits from the bottom of which arises a stem with a flat expanded top, almost level with the margin of the pit, the top being a diamond-like central point. These glisten most on the dark areas; the wings and appendages seem to be without them. They vary in density of distribution, in places being in close rows.

I may quote a letter from my old friend the late Dr. Chapman. He says:—

"The resemblance of *bibulus* to *w. album* is, no doubt,



Vaus & Crampton.

LACHNOCNEMA BIBULUS. PUPAL SKIN.

purely accidental and does not suggest any necessary affinity. The hairs (?) again are not Theclid, but, as you suggest, resemble more the Chrysophanidae."

Dr. Chapman agreed entirely with me that the Theclid and Chrysophanid resemblances were really convergent or parallel developments and not real affinities.

Explanation of Plate III.

There are three figures representing this pupa:—Plate III, fig. 1, shows the cremastral area in which the numerous fine hooklets are a conspicuous feature; figure 2 represents the transverse spiracles, whilst the ventral surface of the pupal skin is shown in figure 3.

IV. *A Contribution to our Knowledge of the Orthoptera of Macedonia.* By Malcolm Burr, D.Sc., F.E.S., etc.; B. P. Campbell, M.D., F.R.C.S.E., F.Z.S. (Scot.), and B. P. Uvarov, F.E.S.

[Read March 21st, 1923.]

Plate IV.

CONTENTS

Foreword.

By M. Burr.

Prior to the war, seventeen species of Orthoptera had been recorded from Macedonia, chiefly by Brunner von Wattenwyl, so that, if we except the neighbouring regions of Thrace and Epirus, it was the least known corner of Europe, and its fauna less studied than that of some of the wilder parts of Asia, and far less than that of the Caucasus. But the Salonika campaign of 1915-1918 enabled a number of naturalists to amass a considerable amount of material from time to time, so far as their military duties and circumstances permitted, and the Orthoptera received a fair share of attention. During the season of 1916, I had the opportunity of making a small collection in the neighbourhood of Salonika itself, in which I was materially assisted by my friend Captain F. T. Powell, of the 7th Munster Fusiliers; while in 1917 I was able to do a little field work in the valley of the Struma during the early part of the summer, and again near Salonika in the later part of the season, when my friend Major E. Burstal, R.A.M.C., assisted me. In the summer of 1918 I was fortunately able to enlist the energetic assistance of Captain B. P.

Campbell, R.A.M.C., with the result that more material was accumulated during that season than in the two previous summers together. From time to time, other districts were visited, but it will be understood that conditions were seldom favourable to field work, and that some of the material, more especially from the Struma Valley, was unfortunately lost or destroyed.

Considering that all the material was captured and observations were effected at odd times in the intervals of duty, mostly on casual occasions, with inadequate or improvised apparatus, the results are not unsatisfactory, though three seasons' residence in so interesting and little known a country should have produced still larger series of the new and lesser known forms. It was an immense relief to turn to Entomology, though the whole country and life teemed with interest, and on many a long trek, pleasure and science were mixed with duty.

We are fortunate in having secured the services of Mr. B. P. Uvarov, F.E.S., to contribute the systematic part of this paper. His familiarity with the Russian and Caucasian Orthoptera adds great weight to the zoogeographical observations.

The localities referred to in these notes are, with very few exceptions, included in what was the area of the British Army in Macedonia, the majority from the district at the back of the town of Salonika.

The country consists of a series of mountain ridges and masses varied with plains. The most striking of the former is the lofty series of crystalline schists running from the three-fingered peninsula and complex mass of Chalcidice in a westerly direction behind Salonika, coming to an end at the river Galiko. It is this range that formed the famous "birdcage" of the Salonika fortifications. Behind the town they form the plateau of Hortiack, once the home of a mass of hospitals and convalescent camps, with the picturesque villages of Hortiakeui and Kirechkeui. The latter name means in Turkish "Lime village," and it is also known by the Greek name of Asvestohori, which means the same thing; it is situated near a mass of marble, which is the local supply of lime. These heights are covered with a dense thorny scrub of stunted *Ilex*, but there is a fine forest of beech on the slopes of the peak of Kotos, which is the highest point in the neighbourhood, rising to an altitude of 1200 metres, or about 4000 feet, above the sea.

The plains are all lacustrine deposits, and are often very fertile. The campagna of Salonika, once the seat of innumerable camps and dumps of all allied armies, is a naked rolling plain extending to the north-west to the ridge mentioned above, and to the west as far as the river Galiko, and then beyond to the broad valley of the Vardar, covering 1715 square kilometres. The main road from Salonika to Seres, the artery of our XVIth Corps, runs from the city in a northerly direction across the campagna, and cuts the ridge 12 kilometres from the town in the gorge of Derbend, where it descends into the open plain of Langaza. This is the site of the old lake of Mygdonia or Volve. The process of desiccation has left two relics of the old, more extensive body of water, that is, the Lake of Langaza or Aivasil, and of Beshik. The former is called after the little town of Langaza, with very old sulphur baths, or the village of Aivasil on its southern bank, with an old Byzantine keep and a fish-exchange. Beshik shares its name with two Turkish villages, now inhabited by Greek refugees, on its northern bank, and with the mass of mountains to the north of the lake, extending to the valley of the Struma. The two lakes are to-day disconnected; they are shallow, but extensive; that of Langaza has an area of 51 square kilometres, and Beshik 69 square kilometres. The latter is very long and narrow, and both lie in an east by west direction. From Derbend, the main road continues northwards to Seres, but a branch turns abruptly eastwards, and skirts the mountains and the lakes to the sea, the old line of the ancient road to Constantinople. Beyond the marsh at the east end of lake Beshik, a swift and clear stream, the Rendina, runs 6 kilometres out into the sea at the Gulf of Orfano or Rendina, cutting the ridge which here swings northwards, skirts the coast, and merges in the Beshik plateau. The gorge of the Rendina is very picturesque, and opens out into the pleasant Gulf of Orfano, a delightful riviera, with the villages of Stavros, which was a military and naval base, Vrasna and Asprovalta and Tazli. In the mountains behind Stavros is Stagiros, the birthplace of Aristotle. The gulf faces Kavala and the island of Thasos, and the front line ran into the sea at the northern end. A narrow belt of swampy land separates the hills from the sea; it is extremely malarious, so the villages are all at a substantial height up the hills; the flats are covered with impenetrable jungles of *Eleagnus*

thorn, and dense forests of planes, the picturesque *Cercis*, on which Judas Iscariot is said to have hanged himself, pistachio and *Arbutus*. The forests are inhabited by wild boar and roe, while packs of jackals frequent the flats.

The Struma valley is a flat, rather broad, rich and fertile plain, with vines and opium poppies, dotted with Turkish villages, which were evacuated and largely demolished, owing to the stiff fighting of which it was the scene. The swarms of mosquitoes, however, defeated both armies, and in the summer compelled both British and Bulgar to retire to their respective hills, leaving 12 kilometres or so of No Man's Land between them.

Almost due north of Salonika, at a distance of some 60–70 kilometres, is the picturesque mountain-girt lake of Doiran, with an area of 42½ square kilometres, famous in Herodotus for the abundance of its fish; the Graeco-Serb frontier crosses the lake obliquely, leaving the railway station in Greece, and the pretty little town of Doiran in Serbia. The war has scarcely left one brick standing on another.

In the middle of the plain of Langaza is the sharp isolated peak of Deve Kran, the Camel Hill in Turkish, which was known to our armies as Gibraltar.

Facing Salonika in the gulf is a peak called Karaburun, or Black Nose, in Turkish, with open fields of cotton and corn, and salt pans.

The climate of the district is Mediterranean, very hot and dry in summer, and mild and clear in winter. January is a delightful month. Mosquitoes and sandfly made the hot weather a misery and kept the hospitals full. From time to time the notorious *Vardarats*, or north wind, would blow like a hurricane, lasting sometimes for several days, flattening camps and spreading destruction. In the winter it brought snow blizzards, like the famous one of November 1915, which inflicted such hardship and distress upon our handful of troops then operating in southern Serbia north of Doiran; in the spring and autumn it brings tropical rains that convert dry stream-beds into raging torrents, unfordable, and often damaging bridges. In the summer it brings red sandstorms, and of all three gifts from the *Vardarats* we hated the sandstorms most. Only at considerable altitudes, as on the top of the peak of Kotos and near Doiran, do we find the Mediterranean climate modified and approaching the Central European.

The vegetation is of course Southern; apart from the plants already referred to, we find figs, olives, cornel; and in the spring the mountains are ablaze with a mass of wild flowers, but these are quickly burnt up by the devouring sun.

The most prominent mammals are jackals, hares, foxes, wolves, rodent-moles, and suslik, wild boar, roe, and, further west, deer. The avifauna is very rich. Wildfowl are excessively abundant and varied in the marshes and lakes; birds of prey are very numerous. Of the game birds, the commonest are partridges, both grey and rock, quail, snipe, woodcock, and little bustard; of the smaller birds, apart from the incredible flocks of jackdaws and starlings that frequented the horse and mule lines, the most noticeable were the bee-eaters, rollers, grey shrikes, storks and various wheatears and ravens; of the wild fowl, numerous species of duck, millions of wild geese in winter, swans, divers, coot, a great variety of waders, little cormorants and pelicans.

As to non-Orthopterous insects we had our fair share of the "minor horrors of war," which included mosquitoes, sandfly, lice, ticks, bed-bugs, fleas, and numerous other unpleasant parasites. Of the more cheerful insects, in May, when the countryside was gay with beautiful flowers, *Thais, Papilio machaon, P. podalirius* were common, and dainty *Nemoptera* flitted gently in the gullies and could be caught with the fingers. A handsome black and yellow *Ascalaphus* dashed about near Kirechkeui, and on the plains I often saw a pale species with colourless wings, that hovered in the air like a Syrphid and could give a good bite.

Of reptiles, several species of lizards were numerous, snakes common enough, and there seemed to be two venomous species. Tortoises crawled all over the place and were favourite pets; tree frogs and cicadas added to our chorus, and fresh-water crabs and mud turtles would be found in suitable localities.

1. Field Observations.

By M. Burr.

The first sign of orthopterous life which I detected was an *Aeolopus thalassinus* Fabr., tempted out by the genial sun

at Lembet as early as January 9, in 1916, and appeared afterwards sporadically on fine days, until by March both this species and its congener, *A. strepens* Latr., were on the wing commonly enough, both being species which hibernate in the southern parts of Europe, but the former was the commoner. Both disappear during the summer, while the new generation is maturing, but I found the new ones mature on the Grand Couronné and near Doiran station in the first week of October 1918. Among the *Aeolopus* taken at Lembet there is a male dated May 25 to July 4, 1916, and two females dated August 1918, which Mr. Uvarov has discriminated as a new species *A. burri* Uv., but I failed to note the difference in the field, which is unfortunate, for I might have accumulated a larger quantity of material. It is odd, that after hunting in vain for the highly localised *A. tergestinus* Mühlf., for many years, from the Caspian to the Canaries, I should have thus unconsciously stumbled upon a fifth European and new species at Salonika in this manner. Small Stenobothrid grasshoppers were hatched out as early as March 31, at Lembet in 1916, and in April several other species were recorded, which would probably have been discovered earlier had more time been available. *Anacridium aegyptium* L. appeared this month in the adult state, and Mr. Barrande sent me *Acrotylus patruelis* Sturm., also a hibernating species, adult *Gryllotalpa gryllotalpa* L., an adult female *Pezotettix giornae* Rossi, evidently a survivor from the winter and some minute, freshly-hatched Decticids and Phaneropterids from near Ak Bunar early in the same month. The Mole Cricket was common enough, and the troops often turned them up when digging trenches; they would sometimes fly to light and make quite a flutter in a tent; it seemed to me a smaller race than our northern form.

The best collecting ground near Lembet was the flanks of the sun-baked hills on the flanks of the mountains; here in April, attentive listening betrayed the presence of a small underground cricket. In spite of all my patience, I never succeeded in catching one; the ground was extremely dry and cracked by the sun, and the herbage very scanty; on listening very attentively near the ground, one could detect a clear, high, musical chirp, and a faint, deep note simultaneously. Now this song and these habits were characteristic of *Gryllodes lateralis* Fieb., which I have taken in the Trancaucasus under just the same conditions.

I feel sure it was a *Gryllodes*, and probably the species referred to above. It disappeared after the violent spring rains of April.

In May things began to liven up. A conspicuous species which appeared as early as May 27 on these dried hill-slopes was *Celes variabilis* Pall., but only the red-winged form. The male is so black that he is a prominent object, especially when he opens his crimson wings; he resembles the Alpine *Psophus stridulus* L. The other dominant species on these slopes was *Gampsocleis abbreviata* Br. This is a marbled, pale buff species, with abbreviated organs of flight; it is green or partly so in the earlier instars, but the green colour disappears soon after the last moult. He is a fierce carnivor, sits upon a sprig of grass and pounces upon any passing prey. One day I saw one stalk quietly round the corner of my tent and help himself to a grass-hopper from a pile of captures which I had left to dry in the sun. It was common through the country we visited, but simply swarmed on these slopes. Mr. Uvarov finds that it is a smaller race than Brunner's typical Dalmatian form, and he has given to it the name *G. abbreviatus* sbsp. *ebneri*. It was adult in June, July and August, when it died away. It was found practically everywhere, but the only other localities actually noted were the plain of Langaza and Karaburun, always on the low ground, or at least, not at any notable altitude. I never found it on the Hortiack plateau, for instance. The earliest date that I have noted the adult is May 31, when I first heard his stridulations; his song is prolonged, and he is at it all day long, from morning to dusk, as he stands on tiptoe, so to speak, on a projecting twig, with his eye open for passing insects. He usually chooses a sprig of wild succory for his stance. He seemed to reach the adult stage a trifle later on the flats than on the slopes. Pairing took place freely at the end of June.

The commonest, most prominent and persistent orthopteron in Macedonia in the summer, as indeed throughout the Mediterranean area, is *Decticus albifrons* Fabr. From every cluster of grass or scrub the monotonous tinkling stridulation may be heard throughout the summer. It occurs on Hortiack plateau, but I did not find it on the higher altitude; even so high as the plateau it is generally replaced by its northern congener *D. verrucivorus L.*, which is abundant there in the end of May, as well as a little lower

down at Kirechkeui; it comes down to the hills near Lembet, where I found it mature on May 29.

Another very interesting and characteristic grasshopper on the lower ground was *Tmethis heldreichi* Br., a hitherto little known, essentially Macedonian species. I first found it, in company with Captain F. T. Powell, in a gorge called by the men the "Happy Valley," between Lembet and Jajladjik, on May 5: the purple-blue neck-membrane and coloured femur-linings are conspicuous even at this early stage. I found the first adult specimens at Lembet on May 31, showing that it attains maturity in the short space of four weeks. It is extraordinarily variable in colour, but quickly fades to a dull brown after death, excepting the very strange purple-blue neck-membrane, which is only exposed when the head is pulled forward, and the bright purple spot at the base of the inner face of the posterior femora; the clear white ventral surface quickly becomes discoloured. This feature is conspicuous when leaping, for the insect turns a somersault in the air, thus exposing the white, which of course disappears directly it settles on the ground, with which the mottled colouring so closely assimilates; the ventral white therefore appears to play the same part as the coloured wings of the flying *Oedipodidae*. A yellow tinge at the base of the occiput, a pale narrow border to the metanotum, and canary yellow on the inner face of the posterior femora, which is transferred, as though stained, to the contiguous parts of the abdomen, are constant, but every other part of the body varies in marking and colour, from pale buff pinkish to deep slate. The males are much smaller than the females, more active, and usually darker in colour, sometimes running almost to blue-black, especially on rocks, but usually buff or reddish on sandy ground, while the females are sometimes only cream-coloured. It is sluggish in copulation, and I never saw it expose its purple neck-membrane then, but only in bending its head forward to feed. The elytra are often steel-blue, even in the female. The latest I saw was a single female on the Baldja road on July 30.

On July 26, in a gulch near Lembet, I found a large spider (? *Epeira*), which had entangled an *Aeolopus* in its web. To prevent the struggle of the powerful grasshopper from tearing the web, the spider sprang upon it, and seemed to catch it between the anterior legs, while sitting upon the posterior ones, and, holding it as a squirrel does

a nut, spun it round with extreme rapidity, and in a trice had it tightly bound up in a silken shroud, in which it was put aside as though for a reserve stock of food, while it sucked a chubby *Calliptamus italicus* L., which it had already captured. I then gave the spider an *Acrida* nymph and a *Pezotettix giornae* Rossi, one of which it seized and wound in a broad, loose shroud, in the twinkling of an eye. I had seen a similar spider deal with an *Aeolopus* in the same way at Madeira.

One of the most prominent insects of Macedonia was the "tank" or the "Balkan flea" of the men, the huge, corpulent, sluggish *Bradyporus dasypus* Illig. They were frequently kept as pets in captivity, and the antics of these quaint and unwieldy creatures I have described in some letters to the *Ent. Record* in 1916. They are timid creatures and sluggish. One day I allowed a tame male out for a walk in the scanty herbage on the plain; it strolled about quietly enough, until it suddenly caught sight of a large *Saga*, also a tame one, glaring at it from the top of a succory twig. *Bradyporus* instantly turned and scuttled off, with a rapidity surprising for its ungainly gait. It has a very powerful pair of jaws, and can quickly shear through a very stout thistle, but would have stood no chance once gripped in the vice-like spiny limbs of the monster *Saga*. Another time, a tame one, when crawling about the dinner table, shied at the sight of a fly, just as a horse shies. It seems that one can almost apply the adjective *nervous*, as well as timid, to this great ponderous Orthopteron, but they do actually become tame. Their loud stridulation betrays their presence at once, and they are easily caught in the fingers, but when handled at once squirt out a yellow fluid through the little folds that mark the tergites, and from under the thorax. I could not find that this fluid had any corrosive or evil-smelling property, but the sudden ejection from a dozen or more orifices is startling enough; on cutting them open to clean the bulky abdomen, this fluid runs freely out, but some were dry inside: these had probably recently effected a discharge. But they quickly get accustomed to being handled, and stop using this method of defence. At the same time they can get angry, for I have seen one, when several were in a big cage together, chase another, savagely threatening it with its very large and powerful mandibles wide open, which looked a sufficiently terrifying sight. The colonies are numerous, and

owing to their stridulation, the males are easy to take, but females are much scarcer. The first *Bradyporus* reported was a fine female, taken by Captain Powell, who brought it to camp on May 29, 1916. He found it crawling in the *Ilex* scrub near Ak Bunar. They live in colonies, which advertise themselves by their chirping on low and moderately high ground in May and June. In July they seem to scatter, for occasional isolated specimens occur as late as August and as high as Hortiack plateau. I have found them at Salamanli on July 18, at Lahana on the high ground in colonies on June 29, 1917, and at Djumaa Mah on the Struma on June 14. I have had specimens sent me from Stavros.

One fine summer morning, on July 1, 1918, I was motoring at an early hour on the main road from Naresh to Ambarkeui, where it crosses a long strip of flat country, covered with thin, scrubby herbage. Dew had fallen and the surface of the road was moist, though the grass around was already dry. The whole road was covered with *Bradyporus*, *Decticus albifrons* Fabr., and *Oedaleus nigrofasciatus* De G., evidently enjoying the fresh moisture. The car crushed them freely, and had I had time to stop I could have secured a very large quantity.

Mantids were fairly well represented round Lembet, for we had five species. The common *Mantis religiosa* L. was of course numerous enough everywhere where there were suitable localities, but not adult till August, when we found it frequently enough around Lembet, and also on the Hortiack plateau and on the cape of Karaburun. This species, which matures late, for nymphs are often found late into August, lingers on in favourable spots till Christmas. I have taken it as late as November 6, in 1916, near Tazli, on the Gulf of Orfano, and in the forest near Asprovalta, also in the Gulf of Orfano on December 3 and even on the 26th. But the riviera of the Gulf is a peculiarly sheltered spot. *Iris oratoria* L. is probably commoner than generally supposed, for Captain Powell and I took it often enough by sweeping in the grass and herbage in the dells and gulches in the Lembet area in July and August. Other localities noted are Jaikin on August 23, 1918, Karaburun in the same month, and Guvezne, at 27 kilometres, on the Seres road, where it flew to light, with a vigorous, dashing irregular flight. The small *Ameles* are common enough too, the forms with round and with pointed eyes being

equally numerous and occurring together. Mr. Uvarov identifies both as *A. heldreichi* Br., the Levantine species, but I confess surprise that the pointed eyes are not even a specific character. We found it common enough on grassy scrub wherever there were suitable places; it is adult late in August: nymphs with pointed eyes on the scrub on Hortiack plateau on August 15, and with rounded eyes at Dimitrich on the Struma on June 14; both forms adult at Ambarkeui early in September 1916, and both common in suitable places round Lembet. Another Lembet species is *Rivetina baetica* Ramb., which occurs on the rocky hills at the back of the village in July, but it was not found after the middle of August. I took a nymph on the flanks of Deve Kran on October 5–10, 1916. Our fifth Mantid was *Empusa fasciata* Brullé. The quaint little larvae were common enough round Lembet in August, and the adult insect in June. It is not very common: I came across it on the Struma near Dimitrich on June 14, 1917, and on the 29th. Unfortunately, we were not lucky enough to find any Stick Insects.

Round Lembet Blattids were not numerous. The commonest species was the little *Hololampra marginata* Schreb., which could usually be found crawling on the flowers and stems of the giant thistles in the gulches in May; I first found it in such a locality one evening when running down my first *Bradyporus.* It was common near Ak Bunar in May and June. On May 5, 1916, I found it under stones at Jajladjik and on the 28th at Kirechkeui. On the Struma in June I found it common on thistles in several places. My latest record is September 10, when I took it at Ambarkeui in 1916.* *Loboptera decipiens* Germ. is not very common; I took one on Hortiack plateau in August 1918. The only other locality where I turned it up in Macedonia was Djumaa Mah, on the flanks of the Struma valley, where I found it on June 13–14, in 1917. The city of Salonika itself gave me three more species of Blattids: *Blatella germanica* L. of course swarms in the restaurants of the town, as does *Periplaneta americana* L. in the steam-heated Turkish baths. The third was *Polyphaga aegyptiaca* L., a wild species, of which I picked up a male in the gardens of the White Tower.

Macedonia is very rich in *Sagidae,* for we found no less

* *Ectobius lapponicus* was common on low herbage and big thistles at Djumaa Mah on June 29, 1917.

than three species, *S. natoliae* Serv., *S. ornata* Burm., and a nondescript species described by Mr. Uvarov as *S. campbelli*. The former is an all-green monster, *S. ornata* is a size smaller, but still a very formidable fellow, green, marbled with white, and the last is the diminutive member of the genus and is all green. We noticed no difference in their habits: they were found crawling or sitting on the upper parts of the clumps of scrub, *S. natoliae* being decidedly the least numerous. Late in August Major Burstal, R.A.M.C., gave me a quite brown one which he found on sand at Karaburun, and it would be interesting to know whether this had been a brown specimen all its life, or whether it had turned brown to match the sun-burnt face of nature in the late summer. *S. ornata* was found from June on the scrub on the hills all round Lembet, Ak Bunar, Aivatli, on Hortiak plateau and at Karaburun. The earliest date I have noted is May 23, when I took a very young larva at Kirechkeui in 1916, but a week later I found a much more advanced specimen, almost a nymph, at the same place. I kept a female *S. ornata* alive in a cage for many weeks; she was distended with ova, but her ovipositor was broken and distorted, so she was unable to lay her eggs properly. She tried to scrape a hole in the earth at the bottom of the cage with her ovipositor, but it was too bent and the earth too thin, so she was forced to let them fall on the surface. On the night of July 17–18, 1916, she laid eight eggs, then she waited a night or two; on the 25th she laid four more, and the next morning three more; she was still very big, and seemed troubled with her inability to lay as and where she wished; on August 11 she laid another four, and on the 13th one more. She was still distended, but died on September 8, her abdomen still containing thirteen ripe ova; some of these eventually hatched out, but were unfortunately lost. As the creatures are fierce carnivora, it does not seem probable that they can live in colonies even in their first stages, so it may be a natural procedure for the female to lay her eggs over a considerable period, and in small instalments in different places; but at the same time, the long delay in depositing her ova in this case may well have been due to the unnatural conditions, confined space and distorted ovipositor.

A male *Saga* in a cage I once heard chirp; the sound was extremely faint, an almost inaudible, low short "buzz." Specimens in captivity became active and fed at dusk,

sitting almost motionless all day. Their movements are extremely slow and deliberate. When a brisk grasshopper was introduced into the cage, such as *Calliptamus italicus* or *Decticus albifrons,* and created a disturbance by hopping wildly about, the *Saga* seemed very upset; if touched, it started back, held its long antennae and fore legs vertically, as though on the defensive, and withdrew with short, sudden, rapid movements of recoil. I often watched them, but never saw one actually catch its prey, though if anything alive were left overnight, it was gone in the morning, except for the hard chitinous parts. It was interesting to note the procedure when I presented a stout grasshopper to a *Saga* with my fingers; often enough it would look startled, erect its antennae vertically, and try to push the creature away with its front legs. But occasionally it would seize it with a very swift movement. Now *Decticus albifrons* is one of our largest European Orthoptera, has tremendous hind legs, with which it can give huge jumps, and is armed with powerful jaws, and, like its relatives, is probably almost, if not entirely, carnivorous. But it was a child in the grip of the *Saga,* which seized it instantly in its powerful front legs, just as a *Mantis* does, and the tibia shuts into the femur like a clasp-knife, the double row of powerful spines on each locking the object in; the middle legs assist in the operation. In every instance the victim was gripped breast to breast, and the *Saga* seemed to catch it in this position straight away, because I could never detect the manoeuvring to get it into the required position. Meanwhile, the captured *Decticus* was giving convulsive springs with its long and strong hind legs, of which the *Saga* took not the slightest notice, but with a perfectly regardless calm, quietly started chewing the throat of its victim. The procedure was the same in every instance. The *Saga* invariably began at the soft throat and gradually ate its way into the head capsule, while the hind legs of the *Decticus* continued to kick frantically. This kicking continued until the position of the head became unnatural, that is, until the jaws of the *Saga* had penetrated right into the capsule, which remained merely slightly attached at the dorsal surface. The *Saga* steadily and methodically chewed out the soft parts, and left the capsule, organs of flight, and legs. On one occasion, I inserted a male *Saga* into a cage with a female, at the end of June. The male at once gripped the ovipositor of the female in his jaws and curving

his abdomen up beneath, deposited a spermatosphore in a couple of minutes.

Stenobothrids are not very numerous, either in individuals or in species, compared with more northerly countries. They are out early, for I have found adult female *St. bicolor* Charp. at Jajladjik as early as May 5, 1916, and I am not aware that this species hibernates. I observed at the time young larvae of *Xiphidion*, probably *fuscum*, of a Decticid, *Rhacocleis*, probably *germanica*, *Pholidoptera*, probably *smyrnensis*, and a *Metrioptera* approaching the nymph stage. On May 21, *St. bicolor* and *Omocestus rufipes* were stridulating near Baldja. Both species were very common at Kirechkeui a week later. *St. petraeus* Bris. was fairly common on the high ground at Jaikin, Hortiack and Karaburun, while *Chorthippus pulvinatus* sbsp. *declivus* Bris. was quite common on the low levels, especially in the gorge of the Dendropotamus leading up the "Happy Valley." *Ch. albomarginatus* was common enough on the flat land, as at Karaburun and Langavuk, and I noted a single *Ch. dorsatus* at Karaburun; *Ch. parallelus* I only noted at Langavuk, but it was probably common enough.

The "Happy Valley" was a pleasant enough excursion, a peaceful and pretty spot, usually deserted and within easy ride from camp, but the rocky gorge was not very rich in insects. It was here that I first came across *Poecilimon elegans* and *P. bosphoricus*, which seem to be the characteristic local members of the group; they are common enough, but not abundant, on high herbage, near Aivatli, on Hortiack, round Lembet, as high as the peak of Kotos, and as low as the flats of the Struma at Dimitrich, where I took it on May 31, 1917. *Ancistrura truncata* Uv. (new genus and species) was taken near Lembet. The type is a single male which I took at Lembet on July 6, 1916. I very much regret that I was not in a position to make even an approximate determination in those interesting days, when collecting was of course very casual work, and that I sent home but a single specimen.

On June 3, 1916, when bivouacking near Deve Kran, I found *Poecilimon elegans* adult, *D. albifrons* in the nymph stage, very young *Tylopsis* and *Saga* and *Cal. italicus* just hatched. In the evening, *Hololampra marginata* was common on the big thistles.

Dociostaurus brevicollis was one of the commonest species on the flat ground. I noted it first on June 3; a fortnight

later it was abundant. On June 18, in 1916, I took a single *Ramburiella truchmana*, which is of a beautiful lemon-yellow colour when fresh, in a cornfield below Akbunar and Daudbali. Captain Campbell afterwards found it common in a locality near Lembet, where I took it with Captain Wolley-Dod. At the same time I came across an immature Decticid hitherto unknown to me, distinguished by a rich brown spot on the face; it afterwards turned out to be *Pholidoptera bucephala*, hitherto known from Asia Minor, but frequent enough in southern Macedonia. I found it commonly enough in many localities around Lembet, Aivatli, adult at the end of June. The only other member of this genus which I found was also an Anatolian species, *Ph. smyrnensis*, which I very naturally took at first glance for its very near relative *Ph. chabrieri*, which is common enough along the Mediterranean coast; I found it far from rare, at General's Corner near Aivatli, Naresh and Lembet. The commonest apterous Decticid was *Rhacocleis germanica*, which we found commonly in scrub at Langaza, Jaikin, Lembet, Karaburun and Hortiack. In Macedonia I found six species of *Metrioptera*, *M. grisea*, high on Kotos, *M. affinis*, *M. intermedia*, *M. nigrosignata*, common on low ground, *M. truncata* Wern. at Lembet, Karaburun and Jaikin, and *M. sepium*, which I took at Karaburun in August and on Hortiack plateau, where I also took *M. roeselii*, not a southern species, and well up on Kotos. Captain Campbell's interesting single individual of *M. fusca* Br. W. was probably taken near Lembet. Of the genus *Decticus*, *D. albifrons* is extremely abundant in the later summer and very self-assertive; its northern congener *D. verrucivorus* is very numerous on Hortiack plateau, being in the nymph stage in May. I was surprised to find it on the low ground in the Struma Valley, where I found nymphs numerous on May 1, in 1917, and adult on the 31st. *D. albifrons* I did not find higher than the level of the Hortiack plateau; it died out suddenly at the end of September; at the end of that month I heard it at Karaburun, but it had disappeared on the plain of Thessaly by the second week in September, which is strange. I heard it on September 12 at Ekaterini, under Mt. Olympus, but as late as October 3, at Doiran, in 1918. At Lembet it was not heard after the first week in September.

I found no specially interesting Oedipodids. When

first hatched (late May) they simply swarmed on the open ground, and the horses' hoofs were enveloped in a sort of cloud of them. By the end of June the common species were adult, that is, *Oedaleus nigrofasciatus*, *Oedipoda gratiosa*, *Acrotylus patruelis* and *A. insubricus*. *Oedipoda coerulescens* occurred on the higher levels, but *Oed. germanica* was uncommon. I saw one on the top of Kotos at 1200 metres, a stray one near Lembet, and one on the Grand Couronné near Doiran on October 4, 1918. *Acrotylus longipes* was uncommon. I first found it on the beach on the Gulf of Orfano, between Tazli and Asprovalta in November 1916. Captain Campbell took one flying to light at Lembet on September 9, 1918, which seems a curious way of taking one of this family, and finally I found it on the sandy bed of the Galiko between Naresh and Salamanli on October 19, 1918. *Sphingonotus coerulans* I found at only two places, both times on the sand of a dry river bed, one at Langaza and the other with *A. longipes* in the Galiko. The only other Oedipodid was *Locusta danica*, which was never numerous. I found nymphs at Lembet and Karaburun in August, and adult specimens early in September. There are clumps of reedy marsh along the Galiko where I found *Euprepocnemis plorans* during the first week in September in 1916, and at Yeni Mahallah and Ambarkeui in the same marshes in August, and it was common at Karaburun on August 23; one in the Dendropotamus near Lembet in September 1917; I found it, too, in a very small patch of rushes between Dremiglava and Deve Kran on September 1, 1918, when about one-third of the specimens were still immature. Other species with an erratic local distribution, occurring only in patches of marsh, were *Paracinema tricolor* Thunb., in small clumps of reed near Ushantar, and *Tropidopola cylindrica* Marsh., which I found in Adji Guel, which is a salt lake, in October 1918. These three species are all southern, and only just reach Europe, though widely enough distributed in Africa, but I had not before associated *T. cylindrica* especially with salt marshes.

Of the Acridiidae in the narrow sense, *Anacridium aegyptium* was common, the larvae and nymphs in July and August, adults appearing in April and May. *Calliptamus italicus* was of course one of the commonest grasshoppers about. I noticed the first adult on June 30. The only other member of the family was *Pezotettix giornae*, which was abundant at all altitudes from early August into

November. In that month I found it very abundant along the shores of the Gulf of Orfano in 1916, where *C. italicus* lingered on. This is a very sheltered locality, sheltered by the Beshik plateau from the north and the violence of the Vardar. I found here also in November *Oedipoda coerulescens*, *Acrotylus patruelis*, *Anacridium aegyptium*, *Omocestus rufipes*, all commonly enough. Also the *A. longipes* referred to above; on November 19 I took a specimen of *Arachnocephalus yersini* in my tent, and, as noted above, *Mantis religiosa* lingered on till after Christmas. *Arachnocephalus yersini* is probably common enough, but as a rule is only taken by sweeping, and so easily overlooked. I found it near Deve Kran on October 5–10 and on July 30 in a gulch near Lembet, and at Karaburun in August.

The winged Phaneropterids, in which Europe generally is poor, were well represented in Macedonia. *Tylopsis lilifolia* F., of course, was numerous enough wherever there was any herbage, especially in the gullies which cut the slopes of the hills, and which were usually thick with weeds and wild flowers; both green and buff forms were common enough, but I did not notice any seasonal, local, or other difference between them; the marbled form, *margineguttata* was less common. I took it high on Kotos on August 17 and near Doiran on October 3, both in 1918. *Phaneroptera* was not so common; I took a female at Karaburun and two at Doiran, but unfortunately the specimens are not preserved and the species not determined, but it is most probable that they were the southern species *Ph. quadripunctata.* I was particularly pleased to cone across *Acrometopa*; this is a handsome genus, resembling *Phaneroptera,* but quite twice as large. The Levantine species is *A. servillea* Brullé, recorded from Greece and near Constantinople. The first specimen recorded was a female brought me by a soldier, who took it near Ak Bunar in July 1916; I afterwards found it numerous on big thistles in a gully at Djumaa Mah, an abandoned Turkish village on the slopes of the Beshik plateau at the southern edge of the Struma Valley where I found it adult on June 30, 1917. In June and July, 1918, it was common enough at Karaburun, where our attention was first attracted to it by its stridulation, with which a stray specimen that had flown to light into a tent advertised its presence. The chirp is of the same timbre and quality as that of *Phaneroptera,* but louder and stronger in proportion to its much greater

size, it is also shorter and ends in a characteristic abrupt jerk; like that genus, it is vespertine and nocturnal in habits. In the gully at Djumaa Mah, referred to above, nymphs were common enough on the big thistles in the middle of June, and adult specimens first appeared at the end of the month and beginning of July. Together with *A. servillea* there was a second species. To my very great regret, the specimens I took never reached home, and so none are available for description, for I feel convinced that they are a new species, as they were very distinctively characterised by the markedly blue-green colour, which was in great contrast to the grass-green of *A. servillea* and the Italo-Dalmatian *A. macropoda* Burm. In addition, the elytra were not obliquely truncate at the apex, but rounded and as long as the abdomen. It is very unfortunate that so distinguished and handsome a species is not available for study. I never saw it anywhere else but in that gully, nor do I foresee any likelihood of revisiting that battle-stricken field.

In August (15–18, 1918) I spent a few days on the Hortiack plateau. It was now mostly dried up, but in May had been carpeted with a profusion of cranesbills, oxeyes, veronicas, blue irises, petunias, broom rape, campanulas, Canterbury bells, comfrey, soapwort, bugloss, veitches, saxifrages, cornflowers and peonies. Among the Ilex scrub I found the following species: *Omocestus petraeus, Oedipoda coerulescens, A. strepens, Cal. italicus, Pezotettix giornae,* nymphs of *M. religiosa, T. lilifolia, M. grisea, Om. rufipes, D. verrucivorus,* all common enough. More interesting was the capture of a male *Metrioptera roeselii* Hagenb., which is a Central European species; its most southern records known to me are Istria, Croatia, southern Hungary, and south of the Save and Danube, in Bosnia and Serbia. Its occurrence so far south, but on the mountain at a considerable altitude, is very interesting. *M. nigrosignata* was fairly common, and I found one *Saga campbelli,* one *B. dasypus,* one *Rhacocleis germanica,* saw *M. sepium,* and several *Oecanthus pellucens.* On the 17th, I rode up to the peak of Kotos: the road winds up through the picturesque village of Hortiakeui, up through a fine beech forest, until the final summit is reached, protruding beyond the forest, at a altitude of 1200 metres, and commanding a splendid view over the tangled wilds of the base of Chalcidice, the Gulf of Salonika, with

Olympus towering beyond, and the treeless mass of the Salonika mountains fading away to the north-west, while to the north, the picturesque plain of Langaza, with the two oblong lakes shimmering in the sun and the massive plateau of Beshik beyond. When we dismounted to water our horses I took a single *Meconema thalassinum* De G., which I regret to say was afterwards lost. This is unfortunate, though there is no question about the determination, for this is a characteristically Central European species; so far south one would expect to find *M. brevipenne* Yers., the Mediterranean form. *M. thalassinum* ranges as far north as Sweden, but towards the south does not extend beyond the northern coasts of Spain, the extreme north of Italy, the southern Tirol and Slovenia and the Caucasus. It is very interesting thus to find two relics of the Boreal fauna on this mountain top on the coast of Macedonia. About a third such species I am in doubt, but think I recognised *Oedipoda germanica*; this is less remarkable, but it is still an essentially Central European species, although ranging further south than the other two referred to. Other species noted on the peak were *Oed. coerulescens*, *St. bicolor*, *F. auricularia*, of which half were macrolabious, *Metr. grisea*, *M. nigrosignata*, *Pezotettix giornae*, *Acrydium depressum*, *Metr. sepium*, *T. lilifolia*, *T. viridissima*, *D. albifrons*, *C. italicus*, *St. petraeus*, all of which are common enough meridional species, *Om. rufipes*, *T. viridissima*, and *Ch. albomarginatus*; also a *Poecilimon*, which must have been *P. elegans* or *P. bosphoricus*, the former a general Levantine species, the latter recorded from the shores of the Bosphorus.

The Conocephalidae were not so well represented as they are further north, for we found only two species, the common *Homorocoryphus nitidulus* Scop., and *Xiphidion fuscum* F., neither of which call for comment. The former I took only at Doiran, the latter common at Karaburun in the salt pans, at Guelbesi, where it was immature in July 1918, and round the edges of Lake Doiran. One of the Karaburun specimens had a rather curved ovipositor, but Mr. Uvarov does not consider that any of the specimens are referable to *X. thoracicum* F. de W.

Of the Tettigoniidae, *T. viridissima* was abundant. I found it adult at Dimitrich in the Struma valley on May 31, in 1917, and I found it on Kotos. Captain Day, M.C., R.A.M.C., wrote me that he took *T. caudata* at Karasuli,

on the branch line joining the two railways of Guevgueli and Doiran, while Major Burstal claimed it for Karaburun. I cannot vouch for these identifications, but there is nothing improbable in their occurrence. Captain Day also reported *Saga ornata, L. danica, Oed. gratiosa* and *Ph. smyrnensis* as being common.

The crickets were, I fear, somewhat neglected; *Oecanthus pellucens* Scop., was abundant from July on herbage and grass, a smaller and paler form than the Caucasus race; a single *L. bimaculatus*, an African species, is noted from Salonika. *Nemobius gracilis* B. Jakovleff and *Gryllus tartarus* var. *obscurus*, Uv., were common enough visitors to our tents at Lembet, flying to light in July and August. The southern and eastern *Gryllus desertus* Pall. was common, at Karaburun, Salonika, and on the Hortiack plateau, and in the Struma valley and Lembet, where *G. burdigalensis* Latr. was numerous too. *G. domesticus*, together with other household pests, found its way into our cookhouse at Lembet. *Arachnocephalus yersini* Sauss. (in my tent on November 19 at Asprovalta) was often enough taken by sweeping in low herbage in the gullies near Lembet in July and at Karaburun in August. *Tridactylus variegatus* Latr. I found only in the mud in a stream bed at Saraj near the lake of Langaza and Beshik. *Gryllotalpa gryllotalpa* was very common; it sometimes flew to light with a strong dashing flight.

What was perhaps the most interesting observation made during the whole of the three seasons was on October 19, 1918, when resting by the dry river bed of the Galiko, between Naresh and Salamanli; here *C. italicus*, *Sph. coerulans* and *Acrotylus longipes* were extremely numerous; among the swarms I captured a male *C. italicus* and a big female *Sph. coerulans* in copula, and succeeded in preserving the pair, which I brought home and exhibited at the Entomological Society. This mésalliance is the more remarkable as the two species belong to different subfamilies of the Acrididae.

Of *Acrydium* I did not come across *A. subulatum* L., but found *A. bipunctatum* at Saraj between the two lakes, *A. depressum* Bris. on Hortiack on August 17, and on the peak of Kotos on the 7th; also *Paratettix meridionalis* Ramb. in numbers on a dry river bed near Langavuk on August 24, 1918, and at Saraj.

In the first week of October 1918 I revisited Doiran, which

I had last seen under a deep mantle of snow in November 1915; in the meantime the town had been blotted out of existence by our gunfire; the impregnable position of the enemy known as the Grand Couronné was littered with the fresh débris of the recent battle; here I found *St. bicolor*, *Aeolopus strepens*, *Oed. germanica*, *Oed. coerulescens*, while on the lower ground, round the station and the edge of the lake, on October 3–4, *Om. petraeus*, *St. bicolor*, *Ch. albomarginatus*, *A. strepens*, *Ac. insubricus*, *Phaneroptera*, probably *quadripunctata*, *T. lilifolia*, *Hom. nitidulus*, *X. fuscum* and *D. albifrons*.

Occasionally my duties took me outside the area in question, but seldom under circumstances that permitted any collecting. In January 1917 I was stationed at Corinth, where *A. strepens* was common enough; and even at this early date minute green Jettigoniids had emerged from the ova, sunning on wet corn after rain; they were probably *T. viridissima*; and one or two minute Decticid larvae. At Itea, on the north bank of the Gulf of Corinth, in August and October 1918 I caught a glimpse of a red-winged *Acrotylus*, and at Bralo, on the line a little south of half-way between Thessaly and Athens, I saw a female *Rhacocleis*, while *C. italicus* and *Oed. coerulescens* were common at the same date. In the plains of Thessaly in the second week of September I observed no Orthoptera, but was struck by the absence of *D. albifrons*, though on the 12th I had heard him chirping away at Ekaterini, on the Greek coast, below Mt. Olympus.

2. Field Observations.

By B. P. Campbell.

This paper embraces my field observations for the summer and autumn of 1918. In the spring of that year I first met Captain Malcolm Burr, who taught me the rudiments of Entomology, and to whose assistance and encouragement I owe much. Any observations I may have made in the previous year are unfortunately mainly forgotten, and could not be recorded with any degree of accuracy, as no specimens were then collected. Mr. Boris Uvarov kindly identified my specimens at the time when he was examining Captain Burr's collection.

In 1918 the weather remained continuously very hot

and dry from the spring until the beginning of October. The only variation took the form of sudden short and sharp thunderstorms.

MAY.

My earlier observations were confined to the Lembet area, 6 kilometres north of Salonika, and the ground here was partly grass and partly covered with the universal thick hollyoak scrub. To the south and west it merged into a large cultivated plain, while to the north and east it rose to barren stony hills.

Three species are associated in my mind with May. The beautiful Mantid *Empusa fasciata* Brullé was at its height then, and although never numerous its form and colouring always attracted attention. Its larva was comparatively numerous from August onwards, but many must have succumbed in their autumnal youth or during the winter rigours, which would account for the scarcity of adults. *Celes variabilis* Pall. was an early grasshopper and almost the first species to go over. In May the small black male and the much larger brown-coloured female with their bright red wings were much in evidence.

The most noticeable object, however, was *Bradyporus dasypus* Illig., which gained the name of "Tank" by reason of its massive size and ungainly gait. It congregated in large colonies, and its loud stridulation was a feature of the June evenings. Though perfectly harmless they were held in considerable awe, and no doubt were credited with powers of evil in proportion to their size. I kept a number under natural conditions in a wire gauze enclosure, and their habits were a source of much interest and amusement. One of these colonies was located at Lembet. *Bradyporus* usually prefers open ground with patches of low scrub, and the loud stridulation speedily reveals the presence of a colony. The male alone stridulates by raising the posterior border of the pronotum and rapidly vibrating the underlying rudimentary elytra, and the sound so produced is most striking, closely resembling the discharge of a small alarm clock whose bell has been muffled. Males were numerous and easily found, but I rarely came across females, which were probably less numerous and more difficult to discover, since they never stridulate and appear to remain more under cover. Stridulation was continuous during the early morning and late afternoon and evening, but during the heat of the day

there was almost invariable silence. The sound is undoubtedly produced to attract the female, and I frequently noted that when a male commenced to stridulate the female would at once come to a halt and listen intently. The insects are apparently almost entirely herbivorous, and I never saw one attack a live grasshopper, but once found they had partly consumed the carcase of a deceased mate. My captives lived until the middle of August, at which date the species went over.

JUNE.

Lembet still remained my hunting ground. *Empusa* was still found, but was becoming increasingly scarce. *Rivetina baetica* Ramb., which reached maturity about the end of the month, was the next Mantid to appear. It is brown or greyish in colour, very similar to that of the barren stony ground on which it is found, and each hind-wing is marked with a beautiful peacock eye. Its distribution was very local, and I only found it on the higher ground at Lembet, where it was quite common. I never saw *Rivetina* in flight, although the wings of the male are well developed. At the end of the month a few small *Mantis religiosa* L. larvae were to be found in the scrub.

A number of grasshoppers made their appearance during the month. The red-winged *Celes* continued numerous. In the middle of the month *Oedipoda gratiosa* Serv. and *Oed. coerulescens* L., *Acrotylus patruelis* H.-S. and *Acrot. insubricus* Scop. were found nearly everywhere on barren country, and their active movements and flashing coloured wings added much beauty. *Calliptamus italicus* L., the commonest and most widely distributed of all the grasshoppers, appeared at the same time, and was shortly followed by the more sluggish *Oedaleus nigrofasciatus* de Geer, with his green-tinted wings. The body-colour of these various insects showed great variation, and usually approximated the ground-colour of their haunts. The straw-coloured *Ramburiella truchmana* F. W. was fairly numerous on the higher barren ground, and was usually found in the same places as *Celes*. The two large insects *Anacridium aegyptium* L. and *Tettigonia viridissima* L. were occasionally met with, but Lembet being almost devoid of their favourite long grass and rushes did not offer sufficient attractions.

Tmethis heldreichi Br. W., one of the most striking insects, appeared early in June, and was quite numerous on the higher barren ground. It is a heavy, flightless insect with abbreviated elytra, and its colour is either light brown or slaty blue according as it inhabits plough or stony ground. The under part of the body is pearly white, and when the insect jumps it nearly always turns a back somersault exposing this surface. The most distinctive feature, however, is a large violet blue patch at the proximal end of the inner surface of each posterior femur, and a similar coloured membrane which is only apparent when the head is pushed forward from the anterior border of the pronotum. The significance of these brightly coloured areas may not have been determined, but the following explanation appears feasible. When at rest the insect's colouring makes detection difficult. I have never heard it stridulate, and possibly instead of employing this usual mode of attracting a mate it thrusts forward its head and turns out its posterior femora, and so signifies its presence by a conspicuous colour signal.

A few Decticids were noted during the month. Undoubtedly *Decticus albifrons* Fabr. was the most prominent grasshopper in the whole Salonika area, and swarmed everywhere revelling in thick scrub and thistle beds. Its large presence, loud tinkling stridulation, and active movements greeted one at every turn. *Decticus verrucivorus* L. was more locally distributed, and was generally found on higher ground. It is shorter and stouter than *albifrons*, and its elytra do not extend beyond the body, which is usually marked with some green. *Metrioptera affinis* Fieb. and *Metr. grisea* Fabr. closely resemble a small-sized *Decticus*, and were almost equally numerous in the same haunts. These were all essentially scrub-loving insects. *Gampsocleis abbreviata ebneri* Uv. had not been previously described. The colour was greenish grey, there being more green in freshly emerged adults, and the insect had abbreviated elytra and long powerful hind limbs, the female having the characteristic down curved ovipositor. A very active insect, it distinctly prefers tracts of sparsely covered ground, and it was particularly plentiful on Lembet plain. All these Decticids were fierce carnivora, and they apparently reached maturity at the end of May or beginning of June.

July.

From the foregoing it will be seen that May and June might be called the period of initiation, in which most of the early species reach maturity. So might July be called the month of advance, in which many later species are added. Lembet still remained my headquarters, but Langaza plain was once visited and Akbunar on four occasions. The latter place lies 3 or 4 kilometres north-west of Lembet on the southern aspect of the ridge dividing the Lembet and Langaza plains. In company with Captain Burr, Geulbesi, at the western end of Lake Beshik, was visited on the 22nd.

All the June species continued numerous with the exception of *Empusa*, which vanished, and *Celes*, which became very scarce. A pair of the latter, apparently the last of the species, were taken on Langaza plain on the 20th. *Bradyporus*, too, went over at Lembet, where the last I saw were a pair in the second week, and the colonies evidently begin to scatter during this month.

In the middle of July there appeared a distinct small variety of *Calliptamus italicus* L., the female of which was only slightly larger than the male of the earlier variety. Further the large variety went over completely in the first week of September, while the small remained a conspicuous feature until the cold weather in the middle of November. In build and general appearance they were similar, but the smaller presented seven distinct colour variations, three only of which were noted in the large variety. They never interbred, and the smaller were only commencing to copulate when the larger were declining. At the end of August I found two males simultaneously copulating with a female.

The *Mantis religiosa* larvae grew rapidly throughout the month, and I secured my first adult on the 27th. Another larva, that of *Acrida turrita* L., was very conspicuous, and towards the end of the month the curious-looking pale green larva of *Anacridium aegyptium* was frequently met with. Adults of this species were in evidence throughout the whole season.

The genus *Saga*, represented by three species, was the most important July addition, and once seen these large and interesting insects can never be forgotten. They probably came in at the end of June, but were scarce at

Lembet, which yielded me but one *Saga*, a male *natoliae*, on July 8. Not until the 17th, when Akbunar was visited, did these insects again come under my notice. Here they were found on a hillside covered with dense deep patches of hollyoak scrub, and for nine visits during July and August my notes record four large *Sagae natoliae* Serv. (one male and three females) and thirty-two small *Sagae* (nineteen males and thirteen females). On further examination the latter resolved themselves into two species, *ornata* Burm. and one hitherto unrecorded but since named *campbelli* Uv., which, with the single exception of a female taken on Langaza plain on July 20, I noted nowhere else. The bulky *Saga natoliae* with his dark greenish-black occiput is unmistakable, but the smaller species if carelessly viewed might be confounded. *Campbelli* is obviously smaller and slenderer, and two important structural differences should be noted. The female ovipositor in *campbelli* measures 25 to 29 mm. while that of *ornata*, the larger insect, is no more than from 20 to 22 mm. The anterior and middle femora and tibiae of *Saga* are each armed with a double row of powerful spines, the number of which in each row constitutes the second distinction. In *ornata* the femoral spines number 10 or 11 but never 12, there being always 10 spines in at least one row on each femur, while in *campbelli* there are 11 to 14 spines in each row, and 12 appears to be the most usual number. Regarding the tibial spines, *ornata* usually has 11 or 12 but occasionally 10 in each row, while in *campbelli* 13 or 14 spines were always found in at least two of the four rows. All these *Sagae* are very actively carnivorous and cannibalistic, and always lurk in the dense scrub awaiting their victim, which is seized in the powerfully armed front and middle limbs. Their favourite prey appeared to be the large *Decticus albifrons*, which they could easily overcome. Their ferocity probably accounted for their thin distribution, for there were seldom found together more than two or three.

Sagae were kept in captivity many weeks and their habits watched. On introducing a male into an enclosure tenanted by a female he at once stridulated and rapidly approached her. He then seized with his palpi the base of her ovipositor, placed his anterior and intermediate feet on her belly, and brought the hind end of his body close to the ovipositor insertion. The insects were thus

belly to belly but head to tail, so to speak, and the male was bent hoopwise with his head and hind end together. He then exuded some white gelatinous-looking material which adhered for some time, and the insects separated after one or two minutes' contact. Soon afterwards the female attacked and ate the male. This happened on two occasions, on one of which there were two females in the enclosure. I do not know whether this is a normal event in their wild life, but it would certainly satisfy my impression that the male *Saga natoliae* is less frequently met with than the female. After the above-narrated event the two females, both very large insects, closely watched one another, but two or three days later the man-eater surprised the other, and in two hours had completely eaten her with the exception of the hard ovipositor and limbs. She was, of course, enormously distended after this orgy, but a few days' inactivity left her none the worse. Captain Burr received from one who observed the process the following note on a female laying her eggs, and it is of considerable interest. This took place on June 29, on a bare sloping patch of ground at Gugunci, and the observer states: "I watched the *Saga* deposit nine eggs as follows. It crawled along until it came to a piece of ground apparently suitable. It then spread its legs widely, getting a good grip of the ground with its head uphill, and arched its back and lowered its ovipositor until it was at right angles to the soil. Using the ovipositor as a borer it tested the soil, and finding it could make a hole it bored down its full length and then ejected an egg. This operation took about 45 seconds. It then withdrew the ovipositor, and without moving its legs re-inserted it about a quarter of an inch away and repeated this eight times. I then moved the insect on, and brushed away the soil until the eggs were exposed. They were in a double row with their tops nearly two inches below the surface, and they tightly fitted the prepared holes." The eggs are cylindrical shaped, those of *natoliae* being about 12 mm. long, and probably about one hundred are laid in a season. All the *Sagae* showed two colour varieties, the one a more or less uniform grass green and the other a dirty greenish-brown colour.

A number of Decticids were noticed at Akbunar in the second half of July. A few specimens of *Decticus verrucivorus* L. were found lurking in the thick scrub. The straw-coloured *Metrioptera nigrosignata* Costa, *Metr.*

truncata Wern., the brown-faced *Pholidoptera bucephala* Br. W., and *Rhacocleis germanica* H. Sch. were present in fair numbers, and later all these were found at Lembet. A few specimens of *Pholidoptera smyrnensis* Br. W. were also found. This handsome light chestnut-brown coloured insect, with green and black markings, skulked in the deepest and thickest scrub and was dislodged with difficulty.

Langaza plain, an immense tract of level country to the west of the lake of the same name, was visited on July 20. It was chiefly under cultivation, at this season in the form of stubble and plough land. The uncultivated parts were grass land freely decked with large thistles and a few low bushes. Here both the green and the straw-coloured varieties of the slender *Tylopsis lilifolia* F. were abundant. Earlier in the month I had secured a single specimen at Lembet, where the species was rare. My further notes record one female *Saga campbelli* Uv., one *Poecilimon elegans* Herm., many *Tmethis heldreichi*, and a late pair of *Celes*. The usual common species *Calliptamus italicus*, *Oedipoda gratiosa* and *coerulescens*, *Acrotylus patruelis*, and *Oedaleus nigrofasciatus* were also much in evidence. This place was revisited a month later.

On July 22 Geulbesi at the western end of Lake Beshik was visited in company with Captain Burr. The country here was flat and grassy with some scattered patches of tall rushes and thick bushes, amongst which *Tettigonia viridissima* L. was fairly numerous, and a few specimens of a *Poecilimon*, either *elegans* Herm. or *bosphoricus* Br. W., were found. There were also noted *Tylopsis lilifolia* F., *Metrioptera sepium* Yers. and *M. grisea* Fabr., and the larvae of *Xiphidion fuscum* Fabr. and *Euprepocnemis plorans* Charp. On the grassy reaches the main feature was the large number of *Aeolopus thalassinus* Rossi and *Aeol. strepens* Latr., and *Chorthippus parallelus* Zett. and *Chort. pulvinatus declivus* Bris., and the fewer numbers of *Dociostaurus brevicollis* and *Omocestus rufipes* Zett., all of which species were also noted in a grassy hollow at Lembet.

August.

August was both a period of zenith and one of transition, for most of the species were to be found then, although a gradual change was in process and many earlier species were on the wane. *Celes* and *Empusa* were the only real

absentees, and even the latter was now represented by its curious spidery larva which remained fairly numerous until the cold weather drove it into hibernation.

Early in the month the female *Rivetina* was distended and preparing to deposit her ova at the very time when *Mantis religiosa* L. was attaining maturity. *Mantis* was widely distributed wherever there was scrub or long grass. Three colour varieties were noted : pale green with opaque greenish-white elytra, an uniform brown, or a straw colour. In both sexes, as with *Empusa*, the elytra and wings are fully developed and extend beyond the end of the body, whereas in the remaining local Mantids this is a male character only, and these structures were markedly abbreviated in the female. Both sexes, but more especially the male, take short flights when disturbed. When copulating the smaller male stands on the female's back with his front limbs frequently in the praying attitude. The insects face in the same direction and the ends of their bodies are brought together, in which position they remain for several hours. At a later date the female deposits her egg sac on a twig or the side of a stone, for which purpose she brings her hind end in contact with the object and exudes the ova in their soft gelatinous-looking casing. This process occupies two or three hours, and the casing hardens into a yellowish oval-shaped structure closely resembling in every way the sweetmeat known as a "molasses candy." To diverge a moment, grasshoppers adopt the same position for copulation, and it is a curious sight to witness the female taking long flights or making prodigious jumps, while the male retains his position like an experienced jockey. In *Mantis* the proximal end of the inner surface of each anterior coxa is adorned with a large oval patch, either uniformly black or black with a rounded white centre. Its significance seems doubtful, but it may be protective and intended to instil fear, for it is brought into prominence when *Mantis* assumes the fighting attitude. To do so, the insect stands on its slender intermediate and hind limbs, the head and thorax are held nearly vertical, and the body is sharply upcurved. At the same time the powerful anterior limbs are rotated outwards to display the patches, and the elytra and wings are raised nearly vertically with a sharp rustling sound, and stand up like two fans. The general effect is sufficiently alarming, and I have seen these tactics repel the advances of a small

but inquisitive lizard. The praying attitude is, of course, that usually associated with this insect, and it will remain thus for hours, attached to a twig in the inverted position, awaiting the approach of some guileless insect, which is seized with a lightning movement of the praying limbs and rapidly devoured.

Iris oratoria L. reached maturity at the end of July or the beginning of August. The last Mantid, *Ameles heldreichi* Br. W., was a miniature compared with those already described. The adults appeared in the middle of August, the first being found on the 17th. This tiny Mantid was particularly common among the thistles on Langaza plain, and fairly so in the hollyoak scrub at Lembet and Ak Bunar. The male makes free use of his wings, which are colourless and well developed, but those of the female are very rudimentary and are a deep orange colour with a light purple patch. These little Mantids are adepts at catching house-flies, and a few in a wire gauze fly-trap afford much amusement.

An important newcomer was *Acrida turrita* L., the first adults of which I saw on August 4. *Acrida* was found everywhere in large numbers, and presented green and straw-coloured varieties. Its curious form, and the loud rustling sound it produced when in flight, made this insect a very conspicuous object.

The *Sagae*, *Bradyporus*, *Tmethis*, *Ramburiella*, and *Rivetina* all went over in the second half of the month. I took late specimens of *Rivetina* at Lembet on September 5 and October 14, and Major Burstal, R.A.M.C., secured a female *Tmethis* at Karaburun on September 14, but this was quite exceptional.

The minute *Pezotettix giornae* Rossi was found in large numbers in the hollyoak scrub at Lembet and Ak Bunar from the middle of August onwards, and a third species of *Chorthippus*, namely *albomarginatus* Zett., made its appearance. In a grassy hollow at Lembet large numbers of the three *Chorthippi* and two *Aeolopi* species, and fewer *Omocestus rufipes* Zett., *Om. petraeus* Bris., *Om. viridulus* L., *Dociostaurus genei* Ocsk., *Gomphocerus maculatus* Thunb., and *Stauroderus biguttulus* L. were seen.

During a second visit to Langaza plain on the 24th *Tylopsis* was still numerous. So also was *Ameles*, and a few *Metrioptera nigrosignata* and *Metr. truncata* were noted. One female *Metr. fusca* Br. W., apparently the

only locally recorded specimen of this species, and a female *Ramburiella*, the last of the season, were also secured.

Oedipoda germanica Charp., of which species I secured a single female on the higher ground at Lembet on the 3rd, was a rare insect and apparently inhabits high ground on which the few reported specimens were taken.

September.

September saw further changes in the Orthoptera and many species disappeared from the scene. *Gampsocleis* must have gone over early, for I noted no specimens of this previously numerous species. *Calliptamus italicus*, *Oedaleus nigrofasciatus*, *Chorthippus parallelus* and *Chort. pulvinatus declivus* disappeared suddenly about the end of the first week, and *Decticus albifrons* and *Metrioptera affinis* followed suit in the middle of the month, leaving a marked gap. *Pholidoptera bucephala* and *Pholid. smyrnensis* also retired, and from now until the end of the season *Aeolopus* was the most prominent feature.

On the 1st and 30th I visited Karaburun, a point at the eastern entrance to Salonika bay. The ground investigated was a long belt of tall rank grass sprinkled with patches of rushes, brambles and other low bushes, and separated from the seashore by a number of salt pans. The following tables compare the captures for the two visits.

Species numerous on each visit: *Mantis religiosa*, *Acrida turrita*, *Aeolopus thalassinus* and *strepens*, *Calliptamus italicus*, *Euprepocnemis plorans*, and *Xiphidion fuscum*. Species sparingly present on each visit: *Chorthippus albomarginatus*, *Tropidopola cylindrica* Marsh, *Rhacocleis germanica*, *Omocestus rufipes*, *Metrioptera nigrosignata*, *Locusta danica* L., and *Anacridium aegyptium*. Species found on first visit only: *Chorthippus parallelus* and *pulvinatus declivus*, large variety of *Calliptamus italicus*, *Iris oratoria* (one female), *Tylopsis lilifolia*, *Pholidoptera bucephala* (one specimen), *Decticus albifrons*, *Metrioptera affinis*, *Metr. sepium*, and *Metr. truncata*. During the second visit the tinkling stridulation of *Decticus albifrons* was once heard, but the insect was not located. *Saga campbelli*, *Ameles*, and *Rivetina* were never reported from Karaburun. *Euprepocnemis plorans* and *Tropidopola cylindrica* both apparently like salt, not necessarily from

the sea, for Captain Burr found both species at the inland salt lake Adji Geul near Naresh.

A few days after my first visit to Karaburun, while dining in the open at Lembet, two male *Iris oratoria* flew to the lamp and were captured. No further specimens came my way, and I formed the impression that this beautiful insect was distinctly rare. The female was green coloured with a brownish pronotum, and the males were brown coloured. Both sexes, of course, had the characteristic peacock-eyed wings, those of the female being abbreviated. A few evenings later a female *Acrotylus longipes* Charp. flew to my lamp at Lembet, being the only specimen of this yellow-winged species which I noted. *Locusta danica* L., already noted at Karaburun, was occasionally met with at Lembet from September onwards.

October.

At the beginning of October 1918 the first break in the weather occurred. On the night of the 4th there was a thunderstorm, and on the 5th it was fine but much cooler. On the evening of the 6th a cold wind blew, and it rained more or less continuously until the 9th, during which time it was windy, cloudy, and distinctly chilly. The 10th, however, was bright and very hot, but thereafter very unsettled weather ruled.

During this month the undermentioned species were noted at Lembet. Numerous: *Acrida turrita, Chorthippus albomarginatus, Aeolopus thalassinus, Oedipoda gratiosa, Acrotylus patruelis, Pezotettix giornae,* and the small variety of *Calliptamus italicus*. Less numerous: *Mantis religiosa, Omocestus rufipes, Aeolopus strepens, Oedipoda coerulescens, Acrotylus insubricus, Ameles heldreichi, Locusta danica, Anacridium aegyptium,* and *Empusa* larva. Two very late *Rivetina* females and one *Xiphidion fuscum* were also found.

November.

In the first half of November there were noted *Mantis religiosa, Acrida turrita, Chorthippus albomarginatus, Aeolopus thalassinus* and *strepens, Oedipoda gratiosa, Acrotylus patruelis,* small variety of *Calliptamus, Locusta danica,* and *Anacridium aegyptium*. On the 14th a very cold Vardar wind blew and snow lay on the surrounding hills. Thereafter the weather was very cold, mainly rain and gales, and no Orthoptera were noted.

3. A List of Orthoptera of Macedonia with Zoogeographical Remarks.

By B. P. Uvarov.

The early records on the Orthoptera of Macedonia are very meagre; in fact, only a few odd species have been recorded from that country by Brunner von Wattenwyl * and some additional data supplied in a short list by R. Ebner,† until Dr. Malcolm Burr published in 1917 ‡ some field notes on the Macedonian Orthoptera with a list of species observed; but as he identified the species by memory, without any books, several mistakes occurred in the list. Thus, what he calls *Acrida nasuta* is evidently *A. turrita*; *Omocestus haemorrhoidalis* = *O. petraeus*; *Mogoplistes brunneus* = *Arachnocephalus yersini*; *Ochrilidia tibialis* = probably *Tropidopola cylindrica*; *Arcyptera flavicosta* = *Ramburiella truchmana*; while *Omocestus raymondi* and *Stauroderus vagans* have not been found by me in Dr. Burr's collection, and are, probably, also misidentifications.

In 1922 appeared a fairly extensive list of Orthoptera collected in the Balkans by officers of the French army during the Great War, by L. Berland and L. Chopard §; this list includes already as many as 78 species of Orthoptera from Macedonia, but it is also not free from incorrect identifications, as I have been able to ascertain by an examination of some doubtful species, owing to the courtesy of M. Berland, who sent me the specimens; all those misidentifications are mentioned in my list, so that there is no need to quote them here. The study of the French material enabled me also to find an undescribed species of *Poecilimon* which has been recorded by MM. Berland and Chopard under a wrong name; it is being described below.

The following list is based principally on the collections made by Dr. M. Burr, Dr. B. P. Campbell and Dr. J.

* Prodromus der Europäischen Orthopteren, 1882.

† Ein Beitrag zur Orthopterenfauna der Europäischen Türkei. 2. Orthopteren aus Macedonien und Konstantinopel.—Zool. Jahrb., Syst., xxix, 1910, pp. 411–414.

‡ Entomologist's Record, xxix, 1917, pp. 46–48.

§ Travaux scientifiques de l'Armée d'Orient (1916–1918). Orthoptères.—Bull. Mus. Hist. Natur. Paris, 1922, pp. 166–170, 230–235.

Waterston, but to make it as complete as possible, all previous records are also included, and under each species a full list of Macedonian localities where it has ever been found is given; for the explanation of localities see below (p. 166). Some species in those collections which proved to be new to science have been described by me in a separate paper.*

Forficulidae.†

1. **Labidura riparia** (Pall.).

"One in the docks at Salonika, one at Lembet, near the banks of the river Dendropotamus, and one in the salt lake of Adji Guel, on October 19, 1918, which had fallen into the water, and was swimming awkwardly by doubling its body to and fro."

2. **Labia minor** (L.).

"Was a frequent visitor to light in camp through the summer; I recorded it actually only from Ushantar and Lembet."

3. **Forficula auricularia** (L.).

"One flying in broad daylight in the middle of the morning near Kirechkeui on March 28, 1916. On August 17, I found it fairly numerous on the peak of Kotos, about half the specimens being macrolabious. Macrolabious specimens were common on Deve Kran in the first two weeks of October 1916, and at Djumaa Mah in the middle of June 1917. At Dimitrich, in the Struma valley, I found dried teazle pods on May 10, 1917, almost all containing one or two specimens, which looked as though they were freshly emerged from the nymph, as the colouring seemed so fresh; these were nearly all macrolabious."

Blattidae.

4. **Ectobius lapponicus** (L.).

Environs of Florina, 800 mt. (Berland and Chopard, *l.c.*); Struma; Djumaa Mah.

* Entom. Record, xxxiii, No. 9, 1921.

† Notes on the earwigs are given by Dr. M. Burr.

5. **Hololampra marginata** (Schreb.).

Salonika (Berland and Chopard, *l.c.*); Salonika; Lembet; Ak Bunar; Jajladjik; Deve Kran; Ambarkeui; Kirechkeui; Struma.

6. **Hololampra subaptera** (Ramb.).

Salonika, vi, 1916, one specimen.

The species has been previously known from Spain, Italy, Corsica and Dalmatia, and Salonika is the most eastern record.

7. **Loboptera decipiens** (Germ.).

Yenidje-Vardar; Ostrovo; Florina (Berland and Chopard, *l.c.*); Salonika; Hortiack plateau; Djumaa-Mah.

8. **Blattella germanica** (L.).

Salonika.

9. **Polyphaga aegyptiaca** (L.).

Lembet; Salonika.

This is an Eremian species which in Europe is found only in the southern parts of the Balkan peninsula (up to Dalmatia), where it evidently came *via* Asia Minor.

10. **Blatta orientalis** (L.).

Salonika (Berland and Chopard, *l.c.*).

11. **Periplaneta americana** (L.).

Salonika (Berland and Chopard, *l.c.*); "common in Turkish baths in Salonika" (M. Burr, *l.c.*).

A cosmopolitan species imported on ships.

MANTIDAE.

12. **Ameles heldreichi** Br. Watt.

Macedonia (Berland and Chopard, *l.c.*, under *A. decolor* Charp.); Karaburun; Jaikin; Lembet; Ak Bunar.

I refer all the specimens brought home by Dr. Burr and Dr. Campbell, as well as those recorded by Berland and Chopard which I examined, to this species, but I cannot be quite sure in my identification, since the systematics of the genera *Ameles* and *Parameles* are in a rather hopeless state; the principal character used for separating

species from each other is the shape of the eyes, which seems to be unreliable. Anyhow, the specimens of Berland and Chopard are certainly not *A. decolor*, as their eyes are distinctly pointed and not round.

13. **Mantis religiosa** (L.).

Various localities (Berland and Chopard, *l.c.*); Lembet; Karaburun; Salonika; Hortiack plateau; Stavros.

14. **Iris oratoria** (L.).

Salonika; Karaburun; Jaikin.

15. **Rivetina** * **baetica** (Ramb.).

Salonika (Berland and Chopard, *l.c.*); Salonika; Lembet; Hortiack plateau; Deve Kran.

The Macedonian specimens belong to the typical subspecies (described from Andalusia), the elytra in the males being distinctly shorter than the abdomen, and in the females only reaching its middle.

16. **Empusa fasciata** (Brullé).

Salonika (Berland and Chopard, *l.c.*, under *E. egena* Charp.); Salonika; Lembet; Dimitrich on Struma.

I have not seen the French specimens, but all collected by Burr and Campbell are certainly *E. fasciata*, and I believe that Berland and Chopard recorded the same species under *E. egena*.

GRYLLIDAE.

17. **Oecanthus pellucens** (Scop.).

Lembet; Hortiack plateau.

18. **Pteronemobius gracilis** (B. Jak.).

1871. *Gryllus gracilis* B. Jakovleff, Horae Soc. Entom. Ross., vi, p. 20, pl. i, figs. 3, 3*a*.
1893. *Nemobius mayeti* Finot, Bull. Soc. Ent. France, p. 252.
1912. *Nemobius adelungi*, Uvarov, Horae Soc. Entom. Ross., xl, No. 3, p. 39.
1921. *Pteronemobius gracilis* Chopard, Journ. Bombay Nat. Hist. Soc., xxvii, p. 57.

* A new generic name proposed by Berland and Chopard (*l.c.*) to substitute *Fischeria* Sauss. praeoccupied in Diptera.

After a careful study of extensive series of specimens of *N. adelungi* Uv. from Transcaucasia and Transcaspia, I came to the conclusion that this species is identical with *N. mayeti*, described from Algeria, and also with *N. gracilis*, of B. Jakovleff, from Astrakhan (on the northern shore of the Caspian Sea), and the latter name, being the first used, must stand; my opinion has been corroborated also by Dr. L. Chopard (*l.c.*, 1921), who compared Mesopotamian specimens with the North African ones, and found no differences between them.

The range of distribution of this minute cricket extends all over the Eremian subregion (N. Africa, Mesopotamia, Persia, Aralo-Caspian deserts), and even beyond its proper limits, as is the case in Macedonia, where it must be regarded as a comparatively recent immigrant from the deserts of south-western Asia, *via* Asia Minor.

19. **Pteronemobius tartarus** (Sauss.).

Pt. vitteneti Berl. & Chop., *l.c.*

Isvor (Berland and Chopard).

A careful comparison of the description of *vitteneti* with specimens of *tartarus* leaves no doubt that both species are identical and represent, probably, only an eastern race of *P. heydeni* Fisch.

20. **Liogryllus bimaculatus** (De Geer).

Salonika.

21. **Liogryllus campestris** (L.).

Berland and Chopard record this species without an exact locality.

22. **Gryllus desertus** Pall.

Mikra (Berland and Chopard); Karaburun; Salonika; Hortiack plateau.

23. **Gryllus burdigalensis** Latr.

Lembet; Hortiack plateau.

24. **Gryllus tartarus obscurus**, Uv.[1]

Karaburun, 23, viii, 1918, 1 ♂.

It is a western geographical race of the Eremian *Gryllus tartarus* Sauss. just recently described by me from Caucasus

[1] Described in Entom. Mo. Mag., vii, 1921, p. 50.

and Persia, and it represents a good example of the influence of the Eremian fauna on that of the southern portion of the Balkan peninsula.

25. **Gryllus domesticus** (L.).

No exact locality (Berland and Chopard, *l.c.*); Lembet.

—. **Gryllodes** sp.

Dr. M. Burr told me that he has heard the piping of a species of *Gryllodes* on the Lembet plain in April 1916; though he never succeeded in catching the insect, he could not fail to recognise the characteristic sound after hearing it in Transcaucasia. I am inclined to think that it was *G. lateralis* (Fieb.).

26. **Gryllomorpha dalmatina** (Ocsk.).

Macedonia (Berland and Chopard, *l.c.*).

27. **Gryllomorpha uclensis** Paut.

Salonika (Berland and Chopard, *l.c.*).

This is a Western Mediterranean species, described from Spain, and known also from South France and Algeria; I do not, however, attach much importance to the fact of its occurrence in Macedonia, as the distribution of species of this genus is, as yet, very imperfectly known and the identification may be incorrect.

28. **Arachnocephalus yersini** Sauss.

Vodena (Berland and Chopard, *l.c.*); Kalamaria; Deve Kran; Lembet; Karaburun.

A circum-Mediterranean species.

29. **Gryllotalpa gryllotalpa** (L.).

Tanes, near Salonika; Lahana; Lembet.

30. **Tridactylus variegatus** (Latr.).

Vertekop (Berland and Chopard, *l.c.*); River Struma; Sarai, between lakes Langaza and Beshik.

Tettigoniidae.

31. **Poecilimon elegans** Herm.

Florina (Berland and Chopard, *l.c.*); Karaburun; Lembet; Langaza plain; "Happy valley;" Deve Kran.

Berland and Chopard recorded this species under the

name *P. fussi* Br. Watt., but I have examined the specimen and refer it to *P. elegans*.

32. Poecilimon bosphoricus Br. Watt.

Lembet; "Happy valley."

33. Poecilimon ornatus Schmidt.

Macedonia (Ebner, *l.c.*).

34. Poecilimon flavescens H.-Sch.

Florina (Berland and Chopard, *l.c.*).

I have studied the specimen and agree with the identification.

35. Poecilimon berlandi sp. n. Fig. 1.

Poecilimon brunneri Berland and Chopard, *l.c.*

A single male recorded by Berland and Chopard from Vakoufkeuy, N.E. of Florina, July 1917 (*H. Marcelet*), under the name of *P. brunneri* Friv., has been examined

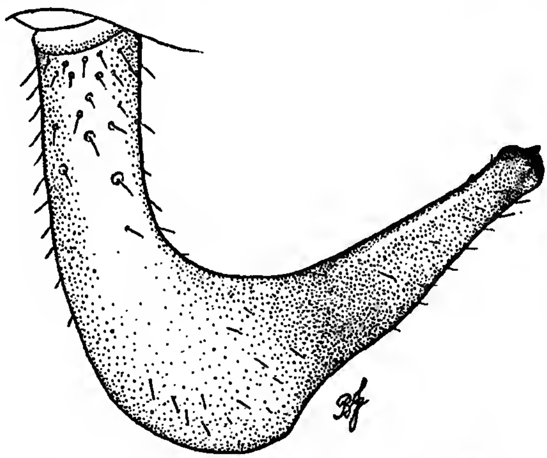


FIG. 1.—*Poecilimon berlandi* sp. n. Left cercus of ♂.

by me, and it is obviously not that species, because its fastigium of vertex is not sulcate and the cerci are differently built; in that latter character the specimen differs from any known one, and I adjoin its description, while I take much pleasure in naming it after my friend Dr. L. Berland.

♂. Size small. Fastigium of the vertex strongly prominent, equally broad throughout, with the apex rotundate-truncate, and

the upper surface somewhat flattened, but not sulcate. Pronotum subcylindrical; its disc hardly selliform, neither inflated nor widened behind; hind margin very broadly excised; lateral lobes almost twice as long, as high, with the lower margin straight in its fore half, while its hind portion forms a regular broad bow together with the hind margin. Elytra half-concealed under the pronotum. Cerci (fig. 1) very large, strongly incurved in their middle; their basal portion cylindrical, straight; the rest flattened, beginning with the middle portion, which is strongly dilated; the apical portion forms a widely rounded right angle with the base, and is directed obliquely upwards, narrowing gradually, with the apex slightly widened, rounded and armed with a short, obtuse spinule, placed nearer to the inner margin; there is also a minute depressed spinule on the inner margin of the left cercus, before its apex, but not on the right one; the underside of the cerci shallowly sulcate. Subgenital plate obtusely tectiform, with the hind margin triangularly excised.

General coloration pale greenish, with sparse reddish-brown puncturation. Antennae with narrow brownish rings. Head and pronotum sparsely punctured with brown; lateral margins of the pronotal disc and a fine median line pale. Elytra with a reddish-brown spot behind. Abdomen with an irregular reddish-brown median fascia; sides of the abdomen are distinctly darker than the upper surface. Front and middle femora reddish brown on their front side and pale with fairly dense brown puncturation, behind. Hind femora with dense brown puncturation, and a brown streak along the upper half of the externo-median area.

Length of body 14 mm.; pronotum 4 mm.; hind femur 13 mm.

36. **Polysarcus denticaudus** (Charp.).

Macedonia (Ebner, *l.c.*).

37. **Polysarcus scutatus** (Br. Watt.).

Lozani, E. of Florina (Berland and Chopard, *l.c.*).

38. **Barbitistes nigrovittatus** Br. Watt.

Macedonia (Brunner v. Wattenwyl, *l.c.*).
Described from a single female and never found since.

39. **Ancistrura truncata** Uv.

Lembet (Uvarov, *l.c.*).

40. **Leptophyes albovittata** (Koll.).

Florina (Berland and Chopard, *l.c.*).

41. **Tylopsis lilifolia** F.

Salonika (Berland and Chopard, *l.c.*); Salonika; Lembet; Ak Bunar; Hortiack plateau; Jaikin; Karaburun; Langaza plain; Guelbesi.

42. **Acrometopa servillea** (Brullé).

Vodena; Lithohoron (Berland and Chopard, *l.c.*); Lembet; Karaburun; Ak Bunar; Djumaa-Mah; Beshik plateau; Struma valley.

Dr. M. Burr told me (see also above, p. 127) that he has collected, but unfortunately lost afterwards, another species of *Acrometopa*, which is probably an undescribed one.

43. **Phaneroptera quadripunctata** Br. Watt.

Izvor (Berland and Chopard, *l.c.*).

44. **Meconema varium** (F.).

Hortiack plateau (see above, p. 128).

Not represented in the collection, but there is no reason to doubt Dr. Burr's record, as no other insect can be mistaken for it. This is the most southern record of this species in Europe.

45. **Saga natoliae** Serv.

Lembet; Karaburun; Hortiack plateau.

The Macedonian specimens are green or yellowish, with sparse black markings; the elevated hind margin of the pronotum is, however, distinctly blackened in the whole series.

There is hardly any other Palaearctic genus of Orthoptera, the systematics of which are so hopelessly confused, as the genus *Saga*. The only sources for identification of species are the entirely unsatisfactory descriptions of old writers, like Fabricius, Fischer von Waldheim, Pallas, etc. More recently, Krauss * and Werner † attempted to put the classification of species in order, but the synoptical tables given by these authors are very incomplete, and also based on the characters which are of a very doubtful taxonomic value, being certainly subject to individual variations. Thus, Werner's key is based, primarily, on the number of spines on the front femora, which character

* Sitzungsber. Akad. Wiss. Wien, lxxviii, 1878, pp. 58–60.
† Zoolog. Anz., xxvi, 1903, pp. 529–530.

is very unreliable.* Still less reliable are the colour characters, since most species of *Saga*, like many other Orthoptera, occur in two-colour forms, one green, and another pale with grey pattern, these forms being connected with the intermediate ones. Both the above-mentioned revisions should be, in some cases at least, misleading, because very little, if any, attention has been paid by their authors to the correct interpretation of the old specific names. A fresh revision of the genus *Saga*, based upon large series of specimens and, whenever possible, on the study of actual types or, at least, topotypes, is very much wanted, especially because of the great zoogeographical importance of these wingless insects, which are undoubtedly of a very ancient origin.

46. **Saga ornata** Burm. (?).

Salonika; Excissou (Berland and Chopard, *l.c.*; under *S. vittata*, F.-W.); Ak Bunar; Lembet; Aivatli; Kirechkeui; Hortiack plateau; Karaburun.

S. ornata Burm. has been described, apparently, not from specimens, but from a figure in Savigny, "Description de l'Egypte," and its more recent redescriptions given by Krauss and Werner (*l.c.*) may, possibly, refer to another species. The Macedonian specimens agree fairly well with the figure of Savigny in the proportions of different parts, which enables me to identify them with *S. ornata* Burm. It must be noted, by the way, that *S. ornata* should be a Syrian species, and Burmeister's record that it occurs in Egypt is erroneous, since the occurrence of the genus *Saga* in that latter country is out of the question owing to its natural conditions. I have not seen the French specimens, named by Berland and Chopard *S. vittata*, but there cannot be any doubt that they belong to the same species, and I should not apply to it the name given by Fischer Waldheim to the South Russian insect.

47. **Saga campbelli** Uv.

Hortiack plateau; Lembet; Langaza plain (Uvarov, *l.c.*).

48. **Tettigonia viridissima** (L.).

Lembet; Karaburun; Guelbesi; Struma valley.

* See R. Ebner's study of *S. ephippigera* in Ann. Nat. Hofmus. Wien, xxvi, 1912, pp. 443–446.

49. **Tettigonia caudata** (Charp.).

Salonika (Berland and Chopard, *l.c.*); Lembet; Kara-burun.

The elytra in the females extend beyond the middle of the ovipositor (length of the elytra 50 mm.; hind femur 33 mm.; ovipositor 38 mm.).

50. **Homorocoryphus nitidulus** (Scop.).

Yenidje-Vardar (Berland and Chopard, *l.c.*); Doiran.

51. **Xiphidion fuscum** (F.).

Karaburun; Lembet; Doiran; Guelbesi.

52. **Gampsocleis abbreviata ebneri** Uv. (*l.c*).

Very common in different localities.

This is the southern subspecies of *G. abbreviata* Herm. known from Albania, and it differs from the typical form in its much larger dimensions and in coloration.

53. **Rhacocleis germanica** (H.-Sch.).

Chalcidice: Vassilica; Vertekop (Berland and Chopard, *l.c.*); Lembet; Karaburun; Hortiack plateau; Ak Bunar; Langaza plain; Jaikin.

54. **Pholidoptera smyrnensis** (Br. Watt.).

Yenidje-Vardar; Chalcidica: Vassilica (Berland and Chopard, *l.c.*); Hortiack plateau; Lembet; Ak Bunar; Aivatli; Naresh.

55. **Pholidoptera bucephala** (Br. Watt.).

Salonika; Yenidje-Vardar (Berland and Chopard, *l.e.*); Lembet; Karaburun; Hortiack plateau; Ak Bunar.

Berland and Chopard described this species as a new one under the name *Psorodonotus riveti*, but their lucid description and excellent illustrations make the establishing of the synonymy easy. The mistake in their identification of the genus is quite excusable, since already Brunner v. Wattenwyl himself (*Prodromus*, p. 339) drew attention to the aberrant characters of this species, separating it from all other species of the genus *Pholidoptera* (= *Olynthoscelis*). A careful study of the insect reveals several characters of generic importance which prevent one from identifying it as *Pholidoptera* when using the existing keys to genera. Thus, it must be separated into a genus of its own, but

I refrain from describing a new genus, because Prof. R. Ebner informed me that he came also to the same conclusion, and he is in a much better position to clear up this question as he has got Brunner's collection at his disposal.

56. **Metrioptera nigrosignata** (Costa).

Vakufkeuy, N.E. of Florina (Berland and Chopard, *l.c.*; as a new species *carinata*). Lembet; Ak Bunar.

Dr. H. Karny has shown * that *Platycleis orina* Burr is conspecific with *nigrosignata* Costa, and so is *carinata* Berl. & Chop.

57. **Metrioptera truncata** (Wern.).

Isvor; Vodena; Plati, S.E. of Yenidje-Vardar (Berland and Chopard, *l.c.*, as a new species *minuta*); Lembet; Karaburun; Jaikin; Ak Bunar.

The description of the French authors leaves no doubt that *minuta* Berl. & Chop. is conspecific with *truncata* of Werner, known from Asia Minor, Greece and Turkey.

58. **Metrioptera fusca** (Br. Watt.) ?

One female in Dr. Campbell's collection, from the Langaza plain, belongs apparently to this species, described from Greece, but I cannot be quite certain in my identification without a male.

59. **Metrioptera sepium** (Yers.).

Lembet; Karasouli near Salonika; Guelbesi; Hortiack plateau; Kotos.

60. **Metrioptera macedonica** (Berl. & Chop.).

Sakulevo (Berland and Chopard, *l.c.*).

I do not know this species.

61. **Metrioptera roeseli** (Hag.).

Hortiack plateau, 15–18, vii, 1918, 1 ♂.

62. **Metrioptera grisea** (F.).

Lembet; Guelbesi; Kotos.

63. **Metrioptera affinis** (Fieb.).

Lembet; Karaburun.

64. **Metrioptera intermedia** (Serv.).

Macedonia (Berland and Chopard, *l.c.*).

* Wiener Entom. Zeitung, xxxi, 1912, p. 292.

65. **Metrioptera escalerai** (Bol.).

Salonika; Yenidje-Vardar (Berland and Chopard, *l.c.*); Lembet; Karaburun.

An Anatolian species.

66. **Decticus verrucivorus** (L.).

Exscissou; Florina (Berland and Chopard, *l.c.*); Ak Bunar; Karaburun; Lembet; Hortiack plateau.

The elytra in the Macedonian specimens extend a little beyond the base of the ovipositor.

67. **Decticus albifrons** (F.).

Various localities (Berland and Chopard, *l.c.*); Lembet; Karaburun; Salonika; Deve Kran.

68. **Bradyporus dasypus** Illig.

Numerous specimens from different localities.

There is no sufficient reason to regard this species as being generically distinct from species of the genus *Deralimmus* Caud.* (= *Callimenus* F.-W.), since the characters which are commonly used to separate this latter genus from *Bradyporus* are of not more than specific value; *Bradyporus* being an older name it must have the preference. Besides the genotype, *B. dasypus*, as many as fourteen "species" have been described, but my studies of very long series of specimens from the Northern Caucasus, South Russia, Kurdistan, Persia, Asia Minor and Balkans lead me to the conclusion that the individual variability in the species of *Bradyporus* (apart from *B. dasypus* which is fairly constant in its characters) is enormous, and there exist hardly more than a single species, besides the *B. dasypus*, but it may be subdivided into several geographical races (subspecies). A full revision of the genus will be given by me elsewhere.

69. **Bradyporus obesus** (F.-W.).

Bralo (Berland and Chopard, *l.c.*); Macedonia (Br. Watt., *l.c.*).

I have examined the French specimen.

ACRIDIDAE.

70. **Acrydium bipunctatum** (L.).

Vertekop; Yenidje-Vardar (Berland and Chopard, *l.c.*); Sarai, between the lakes.

* Genera Insectorum, Fasc, 138, 1912, p. 20.

71. **Acrydium subulatum** (L.).

Camp Grossetti, 800 mt.; Sakulevo; Salonika (Berland and Chopard, *l.c.*); Salonika.

72. **Acrydium depressum** (Bris.).

Florina; Ostrovo (Berland and Chopard, *l.c.*); Lembet; Ak Bunar.

I examined the specimen from Ostrovo which belongs to the form with the elongated pronotum (ab. *acuminata* Bris.).

73. **Paratettix meridionalis** (Ramb.).

Lembet; Ak Bunar; Sarai.

74. **Anacridium * aegyptium** (L.).

Lembet.

75. **Tropidopola cylindrica** (Marsh.).

Vardar plain: Tekeli to Kenlike; Karaburun; Adji Guel.

76. **Pezotettix giornae** (Rossi).

Lembet; Ak Bunar; Karaburun; Orfano.

77. **Calliptamus italicus** (L.).

Salonika; Lembet; Hortiack plateau, etc.

The variability of this species, as regards dimensions, coloration and certain morphological characters is well known, but Dr. B. P. Campbell's observations (see above, p. 134) seem to indicate that a more close study of the so-called varieties may give some very interesting and unexpected results. I know the "small variety" mentioned by him, apart from the Macedonian specimens, also from Transcaucasia and some other localities, and it always occurs in the same places as the "large variety," but the difference in the time of their appearance is so noticeable that I should not wonder if they prove to be different specifically, or, at least, as two seasonal forms of one species. A thorough study of the variability of *C. italicus* is very promising, but it must not be a mere description of numberless forms without attempting to establish their genetic relationship.

* The genus is being described by me in the revision of the group *Cyrtacanthacrini*, now in the Press, since it appears that this common Mediterranean insect belongs to an undescribed genus, the name *Acrydium* being now restricted to a genus of *Tetrigidae*, and the genus *Orthacanthacris* Karsch being a quite distinct one.

78. **Euprepocnemis plorans** (Charp.).

Lembet; Karaburun; Galiko; Yeni Mahallah; Ambarkeui; Guelbesi; Dremi Glava to Deve Kran.

79. **Tmethis limbatus** Charp.

Excissou (Berland and Chopard, *l.c.*).

I have studied the only male specimen of this species, recorded by Berland and Chopard under the name *T. accessorius* F.-W.; and I have found that it agrees perfectly well with the description and figure by Charpentier. On the other hand, *Thrincus accessorius* F.-W. is a very obscure species, purported by its author to come from Transcaucasia but never found there, in spite of very extensive collecting done in that country by myself and by many other Russian entomologists; the description and the figure of this species show most clearly that it has nothing to do with *T. limbatus* Charp., since the pronotal keel is in *T. accessorius* raised in metazona as strongly as in the prozona, and it is, accordingly, quite wrong to regard *limbatus* as a synonym of *accessorius*.

T. limbatus Charp. is also a very insufficiently known species; it is very closely related to the South Russian *T. muricatus*, and probably represents only one of its subspecies (the other known ones being *bilobus* St. and *heptapotamicus* Zub.). The differences between *muricatus* and *limbatus* are very clearly given by Brunner v. Wattenwyl (*Prodromus*, p. 182), and I may only add that the fastigium of vertex in *limbatus* is less sloping than in *muricatus*, and scarcely impressed.

80. **Tmethis heldreichi** (Br. Watt.).

Lembet; Langaza plain; Salonika.

This species is usually referred to the genus *Glyphanus* Fieb., but its distinctions from other species of the genus *Tmethis* are too insignificant to be of generic value; I therefore support the opinion expressed already by Stål (Observ. Orth., 2, p. 26) that the genera *Glyphanus* and *Tmethis* should be united.

The shape of pronotum in this species is rather variable, as it is also in other species of the genus. The median keel is in some specimens thicker, lower and with but feeble transverse sulci, while in others it is higher, sharper and deeply cut by the sulci. The shape of the hind angle is also not constant: the angle may be either practically right, slightly rounded at the apex, or it is widely rounded;

in the latter case, the metazona is only slightly longer than the prozona, while it is distinctly longer than that in the case of a rectangular pronotum. The general coloration is also very variable.

81. **Oedipoda germanica** (Charp.).

Doiran; Kotos, 1200 mt.; Lembet; Grand Couronné, near Doiran.

82. **Oedipoda gratiosa** Serv.

Lembet; Kalamaria; Langaza plain.

83. **Oedipoda coerulescens** (L.).

Lembet; Kalamaria; Hortiack plateau; Karaburun; Langaza plain.

84. **Celes variabilis** (Pall.).

Lembet; Karaburun; Langaza plain.
Only the rose-winged form occurs in Macedonia.

85. **Sphingonotus coerulans** (L.).

Galiko; Salonika; Langaza plain.

86. **Acrotylus longipes** (Charp.).

Adji Guel; Lembet; Naresh to Salamanli; Tazli, Gulf of Orfano.

87. **Acrotylus insubricus** (Scop.).

Doiran; Lembet.

88. **Acrotylus patruelis** (H.-S.).

Kalamaria; Lembet; Karaburun.

89. **Locusta migratoria** ph. **danica** (L.).

Salonika; Karaburun; Lembet.

90. **Oedaleus nigrofasciatus** (De Geer).

Salonika; Lembet.

91. **Aeolopus strepens** (Latr.).

Lembet; Karaburun; Doiran; Lake Beshik.

92. **Aeolopus burri** Uv.

Lembet (Uvarov, *l.c.*).

93. **Aeolopus thalassinus** (Rossi).

Lembet; Karaburun; Ak Bunar; Lake Beshik.

* See my paper on the genus *Locusta* in Bull. Entom. Res., xii, 1921, pp. 135–163.

94. **Paracinema tricolor** (Thunbg.).

Hortiack plateau; Ushantar.

95. **Arcyptera fusca** (Pall.).

Macedonia (Ebner, *l.c.*).

96. **Ramburiella truchmana** (F.-W.).

Lembet; Salonika; Ak Bunar to Daubaldi.

I fail to discover any substantial difference between the genera *Ramburiella* Bol. and *Pallasiella* Kirby; the first name being the older one, it must stand. The genus includes three Mediterranean species: *hispanica* Ramb. (the genotype), *truchmana*, F.-W. and *bolivari*, Kuthy (= *elegans* Uv.*), the latter being closely related to *hispanica* and representing probably only a subspecies of it.

97. **Dociostaurus maroccanus** (Thunbg.).

Lembet; Hortiack plateau.

The elytra in the Macedonian specimens extend only a little beyond the hind knees.

98. **Dociostaurus genei** (Oesk.).

Lembet, 1 ♂ (Dr. Campbell's collection).

99. **Dociostaurus crucigerus brevicollis** (Ev.).

1848. *Oedipoda brevicollis* Eversmann, Addit. quaedam laevia ad Fisch. Wald. Orth. Ross., p. 11, pl. A, fig. 4.

1921. *Dociostaurus crucigerus crucigerus* Uvarov, Bull. Ent. Res., xi, pp. 399, 403 (*nec* Rambur!).

Lembet; Guelbesi.

Owing to some incomprehensible slip, I have stated in my revision of the genus *Dociostaurus* (*l.c.*) that Rambur's *crucigerus* has been described from the South of France, while in fact it is an Andalusian insect and obviously identical with *hispanicus* Bol., and not, as I accepted then, with *brevicollis* Ev. described from S.E. Russia. Thus the Spanish subspecies is the typical form and should be called *D. crucigerus crucigerus* (Ramb.), while the Eastern European race, occurring sporadically, as a relict of the Steppe fauna, all over Southern Europe, should bear the name of subsp. *brevicollis* (Ev.).

100. **Gomphocerus maculatus** (Thunbg.).

Lembet, 1 ♂ (Dr. Campbell's collection).

* For synonymy see my paper in Bull. Mus. Cauc., xii, 1919, p. 156.

101. **Stauroderus biguttulus** (L.).

Many localities (Berland and Chopard, *l.c.*; also in all collections studied by me).

Berland and Chopard recorded this species both under its proper name and under *Omocestus raymondi* Yers., but I have seen some of the specimens named so by them, and they proved to be quite typical *S. biguttulus*. *Stauroderus vagans* recorded by those authors has been also misidentified (see below, No. 105).

102. **Omocestus petraeus** (Bris.).

Jaikin; Karaburun; Doiran; Hortiack plateau; Lembet.

103. **Omocestus viridulus** (L.).

Lembet.

104. **Omocestus rufipes** (Zett.).

Lembet; Baldja; Kirechkeui; Karaburun; Guelbashi.

105. **Chorthippus albomarginatus** (Zett.).

Lembet; Ak Bunar; Karaburun; Doiran; Langavuk.

Recorded also by Berland and Chopard (*l.c.*), without an exact locality, under the name of *Stauroderus vagans* (Fieb.); the specimen they have sent to me under this latter name is a *Ch. albomarginatus* with the lateral keels divergent in the metazona, which is not unusual in this species.

106. **Chorthippus pulvinatus declivus** (Bris.).

Lembet; Guelbesi; Dendropotamus.

All Macedonian specimens are characterised by the thick head with entirely obliterate temporal foveolae (only in some males are the foveolae feebly developed), by the lateral keels of the pronotum incrassate and not reaching the hind margin, and by the elytra extending scarcely beyond the middle of the abdomen. In all these characters they agree well with the representatives of this species from the South of France described by Brisout as *declivus*.

107. **Chorthippus parallelus** (Zett.).

Guelbesi; Karasuli; Langavuk.

I believe that Berland and Chopard recorded this species under *Ch. longicornis*, as this latter is not likely to occur as far south as Macedonia.

108. **Acrida turrita** (L.).

Karaburun; Lembet; Ak Bunar.

A Table Showing the Distribution of Macedonian Orthoptera in Neighbouring Countries.

+ means that the species has been actually recorded.
? ,, ,, ,, ,, not actually recorded, but its occurrence is beyond any doubt.

	Adriatic coast	The rest of Balkans	Western Anatolia
Ameles heldreichi			+
Mantis religiosa	+	+	+
Iris oratoria			+
Rivetina baetica			+
Empusa fasciata	+	+	+
Oecanthus pellucens	+	+	+
Pteronemobius gracilis			+
,, tartarus			?
Liogryllus bimaculatus	+	+	+
,, campestris	+	+	+
Gryllus desertus	+	+	+
,, burdigalensis	+	+	+
,, tartarus obscurus			+
,, domesticus	+	+	?
Gryllomorpha dalmatina	+		+
,, uclensis			
Arachnocephalus yersini	+	+	+
Gryllotalpa gryllotalpa	+	+	+
Tridactylus variegatus	+	+	+
Poecilimon elegans		+	+
,, bosphoricus			+
,, ornatus	+		
,, flavescens		+	+
,, berlandi			
Polysarcus denticaudus	+	+	
,, scutatus		+	+
Barbitistes nigrovittata			
Ancistrura truncata			
Leptophyes albovittata	+	+	+
Tylopsis lilifolia	+	+	+
Acrometopa servillea			+
Phaneroptera 4-punctata	+	+	+
Meconema varium	+	+	
Saga natoliae	+	+	+
,, ornata	+	+	+
,, campbelli			
Tettigonia viridissima	+	+	+
,, caudata	+	+	+
Homorocoryphus nitidulus	+	+	+
Xiphidion fuscum	+	+	+
Gampsocleis abbreviata ebneri			
Rhacocleis germanica	+	+	+
Pholidoptera smyrnensis			+
,, bucephala			+
Metrioptera nigrosignata	+		
,, truncata			+

DISTRIBUTION OF MACEDONIAN ORTHOPTERA (*continued*).

	Adriatic coast	The rest of Balkans	Western Anatolia
Metrioptera fusca			+
„ sepium	+		+
„ macedonica			
„ roeseli	+	+	
„ grisea	+	+	+
„ affinis	+	+	+
„ intermedia	+	+	+
„ escalerai			+
Decticus verrucivorus	+	+	+
„ albifrons	+	+	+
Bradyporus dasypus		+	+
„ obesus		+	+
Acrydium bipunctatum	+	+	+
„ subulatum	+	+	+
„ depressum	+	+	+
Paratettix meridionalis	+		+
Anacrydium aegyptium	+	+	+
Tropidopola cylindrica			+
Pezotettix giornae	+	+	+
Calliptamus italicus	+	+	+
Euprepocnemis plorans			+
Tmethis limbatus		+	
„ heldreichi			
Oedipoda germanica	+	+	+
„ gratiosa			+
„ coerulescens	+	+	+
Celes variabilis	+	+	+
Sphingonotus coerulans	+	+	+
Acrotylus longipes	?	+	+
„ insubricus	+	+	+
„ patruelis	+	+	+
Locusta migratoria	+	+	+
Oedaleus nigrofasciatus	+	+	+
Aeolopus strepens	+	+	+
„ burri			
„ thalassinus	+	+	+
Paracinema tricolor	?	+	+
Arcyptera fusca	+	+	+
Ramburiella truchmana			+
Dociostaurus maroccanus			+
„ genei	+	+	+
„ crucigerus brevicollis		+	+
Gomphocerus maculatus	+	+	
Stauroderus biguttulus	+	+	+
Omocestus petraeus	+	+	+
„ viridulus	+	+	
„ rufipes	+	+	+
Chorthippus albomarginatus	+	+	+
„ pulvinatus declivus	+	?	
„ parallelus	+	+	+
Acrida turrita	+	+	+
Total	63	65	78

Zoogeographical Remarks.

Thus, the total number of Dermaptera and Orthoptera known at present from Macedonia is 108, comprising 3 Forficulids, 8 Blattids, 5 Mantids, 14 Gryllids, 39 Tettigoniids and 39 Acridids. This number should be considered already as fairly close to the actual number of species inhabiting the country, which may be estimated, when all possible species are considered, to be about 130–140 species. Additional species to the list may be expected amongst Blattidae (especially in *Ectobiinae*) and in the Acridid genera *Stenobothrus* and *Stauroderus*, but still more promising seems to me a thorough collecting of the long-horned grasshoppers. In that latter family, two groups are especially claiming attention—*Phaneropterinae*, of which 13 species only are recorded, while the actual number should be surely much larger; and *Decticinae*, in which also many additional, as well as some undescribed species of *Metrioptera* and *Pholidoptera* may be expected. There should be also a few more Gryllids in the country, than there are known at present, as for instance, representatives of the genera *Myrmecophila*, *Mogisoplistes* and *Gryllodes*. Finally, at least one species of the group as yet not represented in Macedonia, of Phasmids, ought to occur there; I mean *Bacillus filiformis* (Cyr.), recorded from Croatia, Dalmatia and Corfu.

Notwithstanding the fact that our knowledge of the Macedonian fauna is, thus, not yet complete, the above list, which includes about 80 per cent. of the actual fauna, may be considered sufficient foundation for an attempt of the zoogeographical analysis of the Macedonian fauna. In this analysis I will leave *Forficulidae* and *Blattidae* out of consideration, for two reasons—first, because the records of the Macedonian representatives of these groups are far too meagre and comprise only widely distributed species; and, second, because I never professed to be a specialist in these groups, and have included them in my list only for the sake of its completeness.

The most important problem concerning the zoogeographical character of the Macedonian fauna is its relation to that of the rest of the Balkan peninsula, on the one hand, and to the western portion of Asia Minor, or the

Western Anatolian district of the Balkano-Anatolian zoogeographical province,* on the other.

When studying the table of distribution of Macedonian Orthoptera in the neighbouring countries (see above, pp. 160, 161) we notice, first of all, that out of 97 Macedonian species not less than 79 occur also in Western Anatolia, and only 14, of which 8 are peculiar to Macedonia, are not known from Asia Minor. At the same time, the number of Macedonian species which do not range into more northern parts of the Balkan peninsula (*i.e.* into Serbia and Bulgaria) is as large as 27. These figures indicate at once that the Macedonian fauna is much less closely related to that of the rest of the peninsula, than to the fauna of Western Anatolia.

Still more convincing figures may be obtained if we will leave out of consideration all the species which are distributed, at least, all over the Balkan peninsula and penetrate also into Asia Minor (55 in number), as well as the species peculiar to Macedonia (9 in number, 6 of them just described). This leaves 33 species of the Macedonian fauna which may be of use in establishing its relationship with the faunas of adjacent countries.

Almost one half of this number (16) are the species common to Macedonia and Western Anatolia, nearly all of them occurring also in Greece, but neither on the Adriatic coast (Dalmatia, Montenegro), nor in Serbia and Bulgaria. Amongst these are some species of Eremian origin, like *Oedipoda gratiosa*, *Pteronemobius gracilis*, *Pt. tartarus* and *Gryllus tartarus obscurus*, one Aethiopian species, *Euprepocnemis plorans*, reaching only the most southern parts of the Mediterranean subregion, but the bulk consists of species of purely Anatolian origin, and their presence in Macedonia leaves no doubt that the latter country, zoogeographically speaking, is but a part of Asia Minor, as is also Greece. This view is strengthened by the fact that 9 of these 16 species are incapable of flight, either in both sexes, or, at least, in the female, which indicates that they cannot be regarded as recent immigrants from Asia Minor, but represent autochtonous elements.

Amongst the remaining 17 species, 6 are common to

* For the general considerations on the Palaearctic fauna of Orthoptera and its subdivisions see my paper, "The geographical distribution of Orthopterous insects in the Caucasus and in Western Asia," in Proc. Zool. Soc. London, 1921, pp. 447–472, 1 map.

Macedonia, Anatolia, Serbia and Bulgaria, ranging partly also further north-eastwards, into Roumania and the steppes of South Russia, but lacking at the Adriatic coast of the Balkan peninsula. In this group, two species of *Bradyporus* belong to the genus originated, undoubtedly, on the inner highlands of Anatolia; the same may be said about *Poecilimon elegans*, *P. flavescens* and *Polysarcus scutatus*, as well as about *Dociostaurus crucigerus brevicollis*. This group, again, supports my view as to the relationship of the Macedonian fauna.

An altogether different group is formed by a very small number of species common to Macedonia and the rest of the Balkan peninsula, including its Adriatic coast, but lacking in Western Anatolia. These species are only 9 in number, and it is very interesting to note that five of them are inhabitants of subalpine regions, or at least of fairly high grounds; they are, as follows:

Polysarcus denticaudus.	*Gomphocerus maculatus.*
Meconema varium.	*Omocestus viridulus.*
Metrioptera roeseli.	

With the exception of *Polysarcus*, which belongs to a genus which probably originated on the highlands of Asia Minor and the Balkan Mountains, the other four species are undoubtedly of boreal origin. Their presence in Macedonia is extremely interesting for the study of the southward distribution of the Boreal fauna, but it does not affect materially the general character of the Macedonian fauna, as these species occur only sporadically on some high grounds and find here the southern limit of their distribution.

There is one more grasshopper with the distribution as that of the five species just mentioned, *Chorthippus pulvinatus declivus*, but its general range is as yet insufficiently known, and I must leave it out of consideration.

Two more species, out of that group of nine, *Poecilimon ornatus* and *Metrioptera nigrosignata*, are of a quite particular interest. They are both common to the eastern coast of the Adriatic Sea and to Macedonia, but not to the more eastern parts of the Balkan peninsula, or to Asia Minor, thus indicating some relationship of the Macedonian fauna to that of the Adriatic coast. It is

difficult, however, to judge about the real character of this relationship, as it is just as possible that either both these species are Anatolian in their origin (though not yet known from Anatolia owing to that country being insufficiently explored), only ranging somewhat farther northwards than other Anatolian species do, or they may have originated in Adriatic countries and extended their range east-southwards. Anyhow, the influence of the Adriatic fauna on that of Macedonia is negligible, if any. It may be mentioned also that *Gampsocleis abbreviata* is represented in Albania and in Macedonia by different races.

Three species, *Gryllomorpha dalmatina*, *Metrioptera sepium* and *Paratettix meridionalis*, cannot be included in any of the previous groups as they are common to Western Anatolia, Macedonia and Adriatic coast, but do not occur in the eastern Balkan countries. As for *Paratettix*, it is Aethiopian in origin, reaching its northern limit in the Mediterranean Sea and penetrating northwards of it only along its coasts, so that it has reached Macedonia *via* Asia Minor, and its absence from the inner parts of the peninsula is quite natural.

Two other species, *Metrioptera sepium* and *Gryllomorpha dalmatina*, are widely distributed Mediterranean species, ranging from Spain, through Italy, Adriatic coast and Asia Minor as far eastwards as the east coast of the Black Sea, but not penetrating either to Serbia or Bulgaria; their distribution again supports my view that the Macedonian fauna is less closely related to that of Serbia and Bulgaria than to Asia Minor.

There remain 9 species which occur only in Macedonia out of all the countries under discussion. One of them, *Gryllomorpha uclensis*, is a Western Mediterranean species, with the distribution as yet incompletely known, and must be left out of consideration. The remaining 8 species may be considered as Macedonian endemics, though it must be borne in mind that as many as 6 of them are just described and they may be found yet in some other countries as well. At least 2 of these species, *Saga campbelli* and *Tmethis heldreichi*, belong to undoubtedly Anatolian genera; and this is true, to a certain extent, also for *Poecilimon berlandi* and *Metrioptera macedonica*, while the affinities of *Barbitistes nigrovittatus*, *Ancistrura truncata* and *Aeolopus burri* are obscure. As for *Gampsocleis abbreviata ebneri*, it belongs to a species known from

Herzegovina and Dalmatia, but not from Serbia and Bulgaria.

Thus, our analysis of the Orthopteran fauna of Macedonia shows most clearly that it differs profoundly from that of the rest of the Balkan peninsula and belongs zoogeographically (probably together with the whole portion of that peninsula south of the Rhodope mountains, but the fauna of those tracts is yet entirely unknown) to the district of Western Anatolia, only very slightly differing from the latter in an admixture of Adriatic forms and, on high levels, of the boreal species. It is, of course, impossible to define the limits of the Western Anatolian district on the Balkan peninsula until the fauna of Albania and of the inner parts of Macedonia is extensively studied, which is only to be desired as it may lead to very important conclusions as to the origin and history of the European fauna.

4. Schedule of Localities.

By M. Burr.

Adji Guel is a small salt lake a few kilometres west of the XIIth Corps road at Naresh; it is very shallow, and the bottom consists of black slime; it is, however, rich in life, and very numerous wild fowl come there to feed. The natives evaporate salt on its banks.

Aivatli is a village just outside the "birdcage," 1 kilometre west of General's Corner, just west of the Seres Road.

Ak Bunar is a hill village some 10 kilometres north-west of Salonika.

Ambarkeui is a village where the XIIth Corps road crosses the river Galiko some 30 kilometres in a north-westerly direction from Salonika, on the foot of the hills of the Beshik plateau.

Asprovalta is a hamlet on the hills on the Gulf of Orfano.

Baldzha is a village just outside the "birdcage," at the foot of the hills, a few kilometres west of Aivatli.

Beshik (i) is the long narrow lake between Langaza and the Gulf of Orfano; (ii) two villages, Great and Little, on the north bank of the lake; (iii) the complex mountain plateau north of the lake and south of the Struma valley.

Daudbali is a locality in the immediate neighbourhood of Ak Bunar.

Deve Kran is an isolated peak rising from the plain between Guvezne and the " birdcage."

Dimitrich is a Turkish village in the Struma valley. It was the winter headquarters of our XXVIIth Division.

Djumaa Mah is a Turkish village on the hills bordering the Struma valley. It was the summer headquarters of the XXVIIth Division.

Doiran is the southernmost town in Serbia, near the Greek frontier, by the lake of the same name; here the Mediterranean climate is slightly modified by continental influence, and more northern forms are found at a lower level. The famous impregnable fortress of the Bulgars, known as the Grand Couronné, is a scarped hill on the south of the town, commanding the plain of Salonika. The Orthoptera referred to from here were taken near the railway station, practically on the Graeco-Serbian frontier.

Dremiglava is a big village between Deve Kran and the " birdcage."

Dudular is a Slav hamlet on the Monastir Road, some 4 kilometres west of Salonika, a site of dumps and hospitals.

Galiko is a river running south past Salamanli and Ambarkeui, emptying itself into the Gulf of Salonika between the town and the Vardar; it is nearly dry after the summer drought.

General's Corner is the name given to a point on the Seres Road where it leaves at pass of Derbend, out of the " birdcage " and enters the plain of Langaza. Here the road forks, the main part running in a northerly direction to Seres, while a branch turns abruptly to the east to the Gulf of Orfano and Stavros. It is at the 12 kilometre stone from Salonika.

Guelbesi is a village at western end of Lake Beshik.

Gugunci was railhead on the Serbian sector.

Guvezne is a village on the Seres Road 27 kilometres north of Salonika.

Happy Valley is the nickname given by our men to a pleasant ravine where the stream Dendropotamus rises in the hills above Lembet.

Hortiack is the plateau behind Salonika, about 3400 feet above the sea, wild and covered with scrub. The site of numerous hospitals and convalescent camps.

Hortiakeui is a village on the slopes of Kotos, above the plateau of Hortiack.

Jaikin is a village on the Beshik plateau a few kilometres north of Langaza.

Jajladjik is a hamlet on the top of the ridge about 12 kilometres north of Salonika.

Karaburun is a cape in the Gulf of Salonika, facing the city, with corn and cotton and salt pans.

Karasuli, in the XIIth Corps sector, a station at the junction of a branch line joining the Doiran and Guevgueli lines.

Kirechkeui is a small town in the pretty valley running eastwards from the Seres road up to the Hortiack plateau.

Kotos is a peak dominating Salonika, rising out of the Hortiack plateau to an altitude of a little over 4000 feet.

Lahana is a village on the highest point of the road over the Beshik plateau from Salonika to Seres.

Langavuk is a big village near Lake Beshik.

Langaza is a small town in the middle of the plain and near the lake of the same name. It is famous for its ancient sulphur baths.

Lembet is a small Vlach village near the Seres road, 6 kilometres north of Salonika, but the name was loosely applied to that part of the campagna of Salonika north-west of the town as far as the hills, a rolling, grassy, treeless plain.

Mikra is a district on the flats east of Salonika, the camping ground of the Serbian army.

Naresh is the place where the Galiko cuts the end of the " birdcage " mountains.

Orfano or *Orphano* is a gulf of the Aegean about 80 kilometres east of Salonika, between the peninsula of Mt. Athos and the mouth of the Struma.

Salamanli is a station 30 kilometres from Salonika on the Doiran-Constantinople line, on the Galiko river.

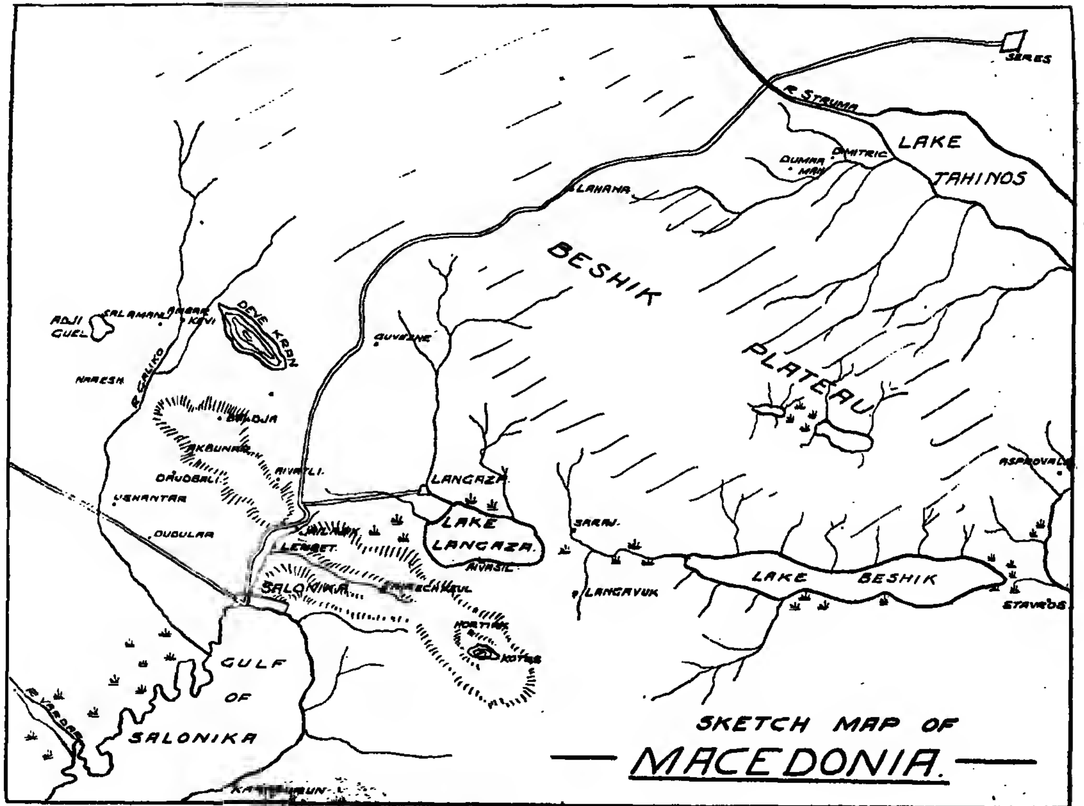
Sarai is a hamlet between the lakes of Langaza and Beshik.

Tazli is a hamlet at the northern end of the Gulf of Orfano, south of the mouth of the Struma.

Ushantar is a hamlet several kilometres further west than Dudular.

Vardar. The estuary of the Vardar is a swampy delta on the west side of the Gulf of Salonika, between the city and Mt. Olympus.

Yeni Mahallah, a common place name, is a hamlet at the foot of the hills near Naresh.



SKETCH MAP OF MACEDONIA.

LOCALITIES IN GREECE.

Bralo: a station on the Larissa-Athens line.

Corinth: the well-known town in the Peloponnese.

Ekaterini is a village on the coast at the foot of Mt. Olympus.

Itea is a small port on the north side of the Gulf of Corinth, near Delphi.

V. *A Lepidopterous Scavenger living in Parrots' Nests.*

By A. Jefferis Turner, M.D.

[Read March 7th, 1923.]

For the material and notes on which this paper is based I am indebted to Mr. H. L. White, the well-known ornithologist, of Belltress, New South Wales. They were obtained by his collector, Mr. Wm. McLennan at Coen, North Queensland, in the Cape York Peninsula, at the latitude of about 14° S. Mr. McLennan came across the larvae of this moth while examining the nests of the Golden-shouldered Parrot, *Psephotus chrysopterygius*. The nests of this parrot are excavations in the termitaria or white-ant-hills, which are very large and numerous in this district. These nests are not lined, and do not contain feathers nor vegetable fibre. From his notes given below, there seems to be no possible doubt as to the feeding habits of the larvae. He appears to have found the larvae, or their remains, in every nest examined, with one exception, and was struck by the cleanness of the nests, and their freedom from excreta of the young birds. The exception was an old deserted nest, and this differed from the others in being caked with dried excreta. He sat down and watched one nest for some time, and observed the larvae actually devouring the excreta as soon as they were voided, even cleaning the feet and feathers of the young birds, which took no notice of them. The larvae were present in large numbers in silken galleries matted together with larvae frass and fragments of earth in the bottom of the nest. They appeared to be on the alert, occasionally one or two came out and explored the bottom and sides of the nest, but when excreta were voided by the young birds they swarmed out *en masse* and rapidly devoured it. Pupation is effected in oval cocoons, which form a cluster in the thinnest outer wall of the nest, and appears to occur when the young birds are fully fledged and ready to leave. In one nest with four eggs no mention is made of any larvae, but four moths were seen, two of them *in copulâ*. Portions of the termitarium containing cocoons were secured, and from them more moths of the same

species have emerged in the Australian Museum, Sydney, and others from a portion received by me.

These habits appear very remarkable. Not all lepidopterous larvae feed on foliage, not all even on vegetable matter. It would be possible to compile a considerable list of eccentric feeders, but among these I doubt if any are more curious than the species I here describe. Among the Diptera, of course, carrion-feeders and filth-feeders are plentiful, but the latter is a new rôle for the Lepidoptera. By what steps larvae of this Order have become adapted to such an unaccustomed diet, it is difficult to imagine. But this instance is an illustration of the fact that life will penetrate, even from unexpected sources, into any crevice where food in abundant.

The larvae have the usual number of well-formed legs, prolegs, and spiracles, and neither they nor the pupae display any important structural peculiarity, so far as I have noticed. The moths resemble large and dingy individuals of the Oecophoridae, to which family I refer them. The palpi, antennae, and hind-wings agree structurally with this family, the antennae being moderately ciliated and with a basal pecten, the hind-wings peculiar only in the stalking of veins 3 and 4. The fore-wings, on the other hand, present very considerable modification of the structure so constant in that family, in the absence of vein 4 (coincident probably with 3), and the long-stalking of 7, 8, 9. I observed the freshly emerged moths run about very actively in the box which contained them.

Gen. NEOSSIOSYNOECA nov.

νεόσσιοσυνοικος, living with nestling birds.

Head rounded with smoothly appressed scales on frons and face; sidetufts moderate. Tongue and maxillary palpi obsolete. Labial palpi moderate, recurved, sickle-shaped, in ♂ slightly exceeding vertex, in ♀ shorter and not reaching vertex; smooth, second joint only slightly thickened, terminal joint much shorter, moderately slender, acute. Antennae with moderate pecten on basal joint; moderately ciliated in both sexes, ciliations slightly longer in ♂. Abdomen in ♀ with a rather long extensible ovipositor. Posterior tibiae with two pairs of long spurs, the inner longer; dorsum covered with long dense rough hairs. Fore-wings with anal vein furcate at base, 1 partly obsolete, better developed towards its

termination, 2 and 3 stalked, or less frequently connate from lower angle of cell, 4 absent, 5 from slightly above angle, 6 from middle of cell, 7, 8, 9 stalked from upper angle, 7 to apex, 9 separating before 7, 10 from $\frac{5}{6}$, 11 from $\frac{2}{3}$, chorda obsolete, media present, unbranched, running to slightly below origin of 6. Hind-wings with two anal veins, 1 present, second anal and 1 approximated in middle, 2 from $\frac{5}{6}$, 3 and 4 stalked from angle, 5 approximated to them at origin, 5, 6, and 7 widely separate, equidistant parallel, 12 widely separate from cell except near base, media present, unbranched, running to below origin of 6.

Neossiosynoeca scatophaga, n. sp.

σκατοφάγος, dung-eating.

♂. 28–35 mm.; ♀. 38–41 mm. Head, palpi, thorax, abdomen, and legs fuscous. Antennae fuscous; ciliations in ♂ 1, in ♀ $\frac{2}{3}$. Fore-wings suboblong, slightly dilated posteriorly, costa strongly arched, apex rounded, termen obliquely rounded; fuscous; an obscure darker discal spot at $\frac{2}{3}$ on end of cell; cilia fuscous. Hind-wings slightly broader than fore-wings, apex round-pointed, termen gently rounded; grey; cilia $\frac{1}{3}$, pale-grey, apices sometimes grey-whitish in apical half of wing.

North Queensland. Coen in May; four specimens in the nest of a parrot, *Psephotus chrysopterygius*. Larvae and pupae also taken in considerable numbers in the nests, some of them emerging in August and September. The type has been deposited in the Australian Museum, Sydney.

Larvae (preserved in spirit, probably bleached and contracted) large stout grubs up to ·32 mm. in length, with the usual number of prolegs and spiracles, grey-whitish; the larger examples with numerous fuscous spots, to which fine hairs are attached; no spots on first thoracic segment, which is dark posteriorly; second and third thoracic segments with one pair of dorsal, and two pairs of lateral spots; abdominal segments with two pairs of dorsal spots, and a spot above and beneath each spiracle.

Pupa (one specimen in spirit, from its size probably a male), length 14 mm. The only peculiarities I have observed in it are two closely appressed finger-like projections, about 1 mm. in length, projecting backwards from the middle of the posterior edge of the thorax on the ventral surface. I am not sure what part these represent, but I think it may be the forelegs.

Cocoons. The portion of termitarium I received had attached to it a quantity of larval frass loosely matted together with silk, among which were a few discarded larval heads. In the mass I found and opened a soft silken tube 25 mm. long, open at one end. This was empty and no doubt represented the gallery into which the larva retreated after feeding, as described by Mr McLennan. There were also several closed cocoons of tougher silk of about the same length. Four of these I opened. One was empty; one contained an empty pupal skin; two contained larvae which had not yet pupated. From their size I take these to be all males. The larvae were able to move about inside the cocoons, which were roomy; they were creamy white without spots, and in this and in their size they corresponded to one of the larvae in spirit. Apparently of the fully grown larvae only the females develop dark spots, or else these spots disappear before pupation.

Habits. I here transcribe almost *verbatim* portions of Mr. McLennan's diary.

May 6th, 1922.—I took a photograph of the termitarium, then opened the nest, and found it contained young birds, one of which was still in the downy stage with scarcely a feather showing. I could not make out what was the matter with the bottom of the nest, it was heaving and undulating in constant movement, little heads were flickering out and in through trapdoor-like openings. At first I thought it was alive with maggots; a few seconds later a number of the insects came right out of the bottom of the nest and started to eat up the excreta, which one young bird had just voided. I then saw that the insects were caterpillars. In a couple of seconds the excreta were eaten up, and the caterpillars at once disappeared into the bottom of the nest through the openings from which they had emerged. I sat and watched them for some time; every now and again one or two caterpillars would come out and go exploring round the bottom and sides of the nest. The young birds were frequently voiding excreta, and at times it would get all over their feet and tail-feathers. Instantly the caterpillars would swarm out and devour it, eating up every scrap even off the feet and feathers of the young birds; thus they were kept scrupulously clean. The young birds did not take any notice of the caterpillars. . . . I examined the bottom

of the nest. The trapdoor-like openings proved to be the mouths of "cocoons," in which the caterpillars lived. These "cocoons" were lightly bound or matted with web, the interstices being filled with the excreta of the caterpillars and the fine chipped dirt in bottom of nest. I secured a number of the caterpillars and also a portion of the bottom of the nest. . . . Further on I found another *Psephotus* nest four feet from the ground in a magnetic termitarium. It contained half-fledged young birds with the attendant colony of scavenger caterpillars. . . . I opened a third nest in a large magnetic termitarium four and a half feet from the ground; it contained one fully fledged young bird, which flew out. The caterpillars in this nest were just starting to pupate, a number of them had clustered their cocoons closely together and bored through to outside of termitarium at the thinnest part of the side of nesting chamber. I secured this cluster of cocoons. Further on I found an old nest, probably of last season. The cocoons of the caterpillars were clustered together in thinnest wall of nest, but all the insects had emerged. Another old nest had a similar cluster in a similar position. Later I found another nest two feet from ground in a spire-shaped termitarium, containing small young just starting to get their feathers, with colony of scavenger caterpillars in bottom of nest.

May 7th.—I found a nest of *Psephotus* seven feet from ground in a big magnetic termitarium; in it small young, not long hatched, and attendant colony of scavenger caterpillars. . . . A couple of miles further on I found a nest from which young had only just flown. The caterpillars were just starting to cluster together at the thinnest wall of nest.

May 13th.—Found several old nests of *Psephotus* with the clusters of empty cocoons in each. I found only one nest from which the young birds had flown this season. There were no signs of any caterpillars in this nest; the bottom of nest was literally caked with dried excreta of the young birds. . . . On looking into another nest I could plainly see four eggs. There were four moths in the nest, two of them coupling; evidently the moths responsible for the caterpillars. I secured them.

May 21st.—A *Psephotus* nest contained five young and the skeleton of a sixth. Red meat ants had raided this nest, and were carrying off the scavenger caterpillars,

but not interfering with the young birds. Another nest contained four young birds almost full-fledged. I broke off termitarium to the level of the nest and photographed the bottom of the nest to show how clean it is kept by the caterpillars.

VI. *On the homology between the Genitalia of some species of Diptera and those of* Merope tuber. By F. Muir.

[Read March 21st, 1923.]

Plates V, VI.

In a previous paper * the writer has figured and described the male genitalia of *Merope tuber* Newm. The Mecoptera are considered by most entomologists as representatives of an archaic group of insects, and the genus *Merope* is a generalised Mecopteron which presents interesting synthetic characters. It is therefore interesting to trace homologies between the male genitalia of this genus and those of some of the more generalised Diptera.

In a species of *Tipula* † (figs. 1, 2, 3) we find in the male a condition of the eighth abdominal segment which is rare among insects. The eighth tergite is small, but distinct; the eighth sternite is large, and on, or near, its apical or posterior margin there is a pair of large, flat processes with their apices produced into a long, slender spine turned at a right angle to the basal portion (figs. 1, 2, *ap.*). From their position there are good reasons for considering these processes as the coxites of the eighth sternite, or as the styles of those coxites, and so equivalent to the anterior processes of the female ovipositor in most insects. The probability of their being specialised structures having no connection with the primitive appendages of the eighth sternite is remote. In the other species dealt with in this paper there are no traces of such processes. The fact that the hypopygia of this *Tipula* and of other species, such as *Ctenophora pectinicornis*, are morphologically similar, indicates that the coxites of the eighth segment take no part in its construction. Herein these insects differ from most of the Homoptera, where the anterior processes or coxites of the eighth sternite are incorporated into the pygofer either as free lobes or fused so as to be

* Trans. Ent. Soc. Lond., 1921, p. 231.

† The form examined is stated by Mr. F. W. Edwards to be near *T. ochracea* Meig., but to belong to a species not at present recognized as British.

indistinguishable. The Cicadidae are an exception, for in them the eighth sternite and its coxites apparently form a large hypandrium below the pygofer.

In *Eriocera greeni* Brun. (fig. 10) the ninth abdominal segment forms a complete ring without any complete division between notum and sternum. The anal segment, which is all that remains of the tenth and eleventh segments, is membranous. The coxites of the ninth sternite (*cox.*) are large, joined to the sterna by a membrane, and bear at their apices a large bifurcate process which represents the style (*st.*). The aedeagus consists of a chitinous subquadrate framework, the dorsal corners of which are produced into small processes (*a*), and the median, ventral portion into a small penis (*p.*) This aedeagus lies between the bases of the coxites, and is in contact with them.

In *Erioptera trivialis* Meig. (figs. 5, 6, 7, 8, 9) the ninth abdominal segment forms a narrower ring than in *Eriocera greeni*, and the tergite is produced into two flat processes, the apoterga (*apt.*). The anal segment is membranous and covered dorsally by the lobes of the ninth tergite. The coxites are large and free from the ninth sternite, and each bears a pair of processes on its apex. The larger of these processes may be the style. The aedeagus consists of a short, tubular penis with its apex expanded and its base bulbous (*p.*), and a surrounding membrane supported by a chitinous framework (*t.*).

If we compare the male genitalia of these two species with those of *Merope tuber*, the homologies are apparent. If the large paired processes in the latter are correctly interpreted as the coxites, then the similar organs in the former must also represent those organs.

In the *Tipula* (figs. 1, 2, 3) the ninth tergite is distinct, the ninth sternite being completely amalgamated with the coxites to form the hypopygium (*hpg.*). This we would call a complete hypopygium, whereas the condition of the former two is incomplete. The style (*st.*) consists of three distinct pieces, a larger inner and two smaller outer processes. The anal segment (*as.*) is membranous with a chitinous framework round its base. The aedeagus is complex. The penis (*p.*) is exceedingly long and slender, the base being developed into a bulb with flanges for the attachment of muscles. This bulb is attached to the framework round the base of the anal segment, and the penis when at rest lies in a large

genital invagination (*gi.*) which extends forward into the sixth or even fifth abdominal segment. The margin of this invagination is produced into a pair of flat, angular processes (*g.*) which appear to act as guides for the slender penis. The slender portion of the penis does not appear to be a complete tube, but a split tube whose edges come together but are not amalgamated. Below the processes at the mouth of the invagination are three other chitinous processes, a pair of strong spines curved ventrally and a median bifurcate chitinous process (*h.*). Below these is a further pair of small processes (*i.*). The medio-ventral line of the hypopygium is membranous except at the base.

In *Ctenophora pectinicornis* L. (fig. 4) the hypopygium is complete with the ninth tergite amalgamated with the sternite. The style consists of two processes. The genital invagination is much shorter and the penis is shorter and thicker. Below the genital invagination there is a large membranous process (*k.*).

The four Tipulids mentioned above were selected at random, but they show an interesting series of developments. A careful study of the genitalia of the family is likely to show still better the lines of evolution, and to be of value to the systematist.

In the Asilid *Rhadiurgus variabilis* Zett. (figs. 11, 12, 13) we find an incomplete hypopygium in which the ninth tergite is developed into a pair of large processes, the apoterga, with bifurcate apices. The anal segment is well developed with distinct chitinised tergite and sternite. The ninth sternite is long in the middle and very short at the sides, and is attached to the basal lateral angles of the tergite. The coxites (*cox.*) are large, free from the sternite, and the style is articulated near the middle of the inner ventral margin. The penis is long and curved, fairly broad at the base and narrowing to a fine tube in its apical half; near the middle there is a pair of slender processes (*l.*). The base is produced into a process on each side, which is joined to the base of the coxite. The whole represents a generalised type.

In *Mycetophila marginata* Winn. (fig. 14) the seventh and eighth abdominal segments are very small and telescope into the sixth; the ninth tergite is fairly large and produced into apoterga. The ninth sternite and coxites are amalgamated together. The styles are complex. The anal segment is large and shows distinct sternite and tergite.

There is a narrow strip of chitin which "hinges" the eighth sternite to the hypopygium (*m.*).

In *Arctophila mussitans* F. (Syrphidae) (fig. 15) the fifth abdominal segment is smaller than the fourth, and the sixth, seventh and eighth are still smaller and have a twist to the left of about 80°. The hypopygium is complete and has a twist of about 160°. The styles are asymmetrical and large, the anal segment is small. The aedeagus is large and complex. The eighth segment is fairly firmly fixed to the ninth so that it acts as a portion of the hypopygium.

The male genitalia of Hymenoptera are on the same plan as those of Diptera and are very probably homologous. In the Aculeata the aedeagus is complex and forms an incomplete tube, but in many of the Parasitica the aedeagus is simple and consists of a tubular tegmen with a pair of lateral lobes and a median lobe, similar to the trilobed type in Coleoptera. This lends weight to the idea that the lateral lobes of Coleoptera are the homologues of the coxites and that the median lobe is the penis. But we must be careful in homologising these organs, as so often new structures arise, especially in the trilobed type. In some Coleoptera there is a distinct pair of lobes arising from the base of the median lobe quite independent of the lateral lobes on the tegmen.

In Diptera the male gonopore appears to open on the ninth sternite or between the ninth and tenth, as it appears to do in most insects. In Homoptera it appears to open between the eighth and ninth in a position similar to that of the female gonopore.

If the above homologies are correct it is interesting to note that the styles of the ninth sternite are present in many adult flies.

These notes are the result of a cursory examination of a few specimens of Diptera, the outcome of a conversation on the subject with Dr. C. G. Lamb, and are published in the hope that they will stimulate other workers with a knowledge of the Order to undertake more extensive comparative studies, which will lead to a better understanding of the morphology of the various complex types of genitalia found in the Diptera.

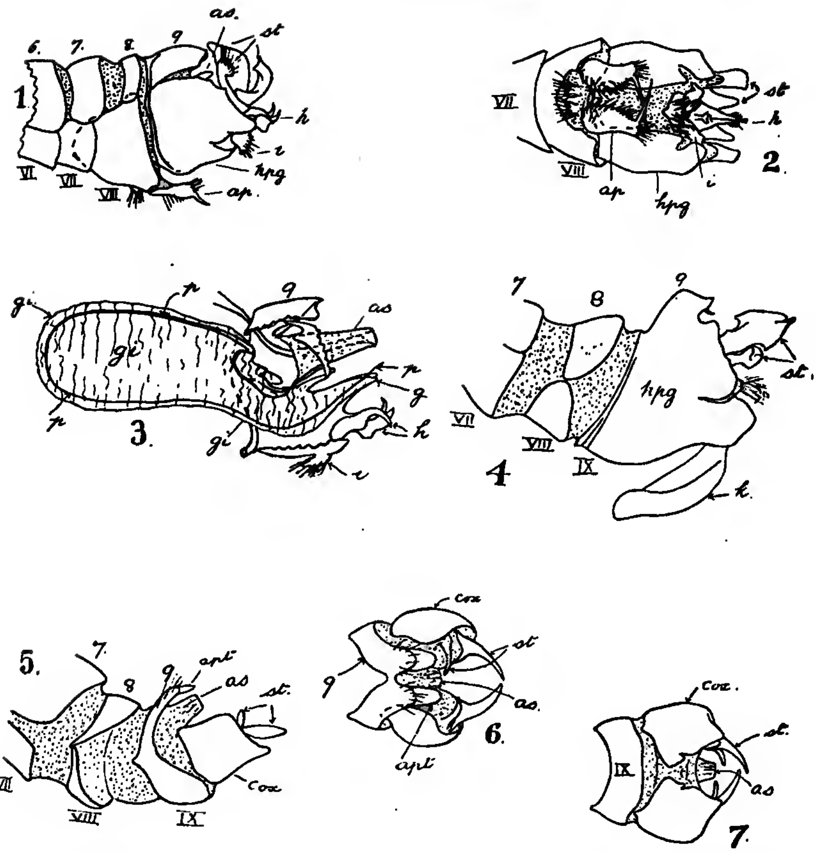
My thanks are tendered to Dr. C. G. Lamb and Mr. F. W. Edwards for identifying specimens for me.

Explanation of Plates V, VI.

Fig. 1. *Tipula* sp. Lateral view of apex of male abdomen.
2. *Tipula* sp. Ventral view of apex of male abdomen.
3. *Tipula* sp. Section through hypopygium slightly on left side of median line.
4. *Ctenophora pectinicornis.* Lateral view of apex of male abdomen.
5. *Erioptera trivialis.* Lateral view of apex of male abdomen.
6. *Erioptera trivialis.* Dorsal view of hypopygium.
7. *Erioptera trivialis.* Ventral view of hypopygium.
8. *Erioptera trivialis.* Dorsal view of coxites and aedeagus.
9. *Erioptera trivialis.* Lateral view of aedeagus.
10. *Eriocera greeni.* Dorsal view of hypopygium.
11. *Rhadiurgus variabilis.* Lateral view of hypopygium.
12. *Rhadiurgus variabilis.* Dorsal view of hypopygium.
13. *Rhadiurgus variabilis.* Lateral view of aedeagus and right coxite.
14. *Mycetophila marginata.* Lateral view of apex of male abdomen.
15. *Arctophila mussitans.* Ventral view of apex of male abdomen.

6–10. Tergites.
iv–x. Sternites.
aed. Aedeagus.
ap. Anterior processes = coxites of viii.
apt. Apoterga.
as. Anal segment.
cox. Posterior processes = coxites of ix.
gi. Genital invagination.
hpg. Hypopygium.
p. Penis.
st. Styles of coxites of ix.

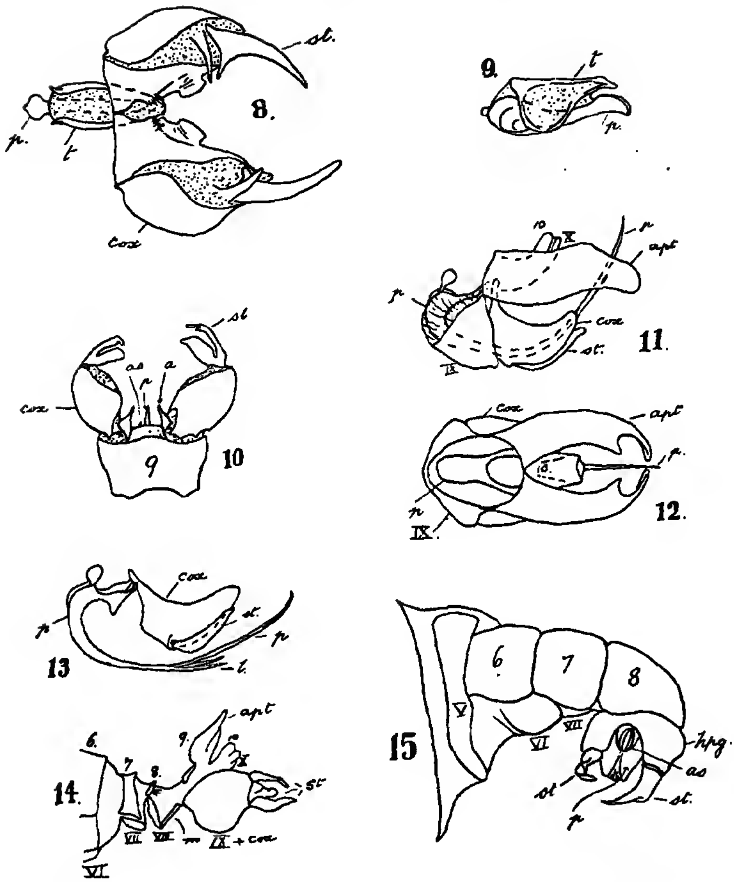
Trans. Ent. Soc. Lond., 1923, *Plate V.*



F. Muir del.

Vaus & Crampton.

GENITALIA OF DIPTERA.



F. Muir del.

Vaus & Crampton.

GENITALIA OF DIPTERA.

VII. *On the Mouth-parts of the* Micropterygoidea (*Order* Lepidoptera).

By R. J. Tillyard, M.A., Sc.D.(Cantab.), D.Sc.(Sydney), C.M.Z.S., F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Institute of Scientific Research, Nelson, N.Z.

[Read March 7th, 1923.]

(With Twelve Text-figures.)

The research which forms the subject of this paper was originally intended to form the second part of a series of papers on the Morphology of the Micropterygidae (*s. lat.*), of which the first part, dealing with the wing-venation, has already been published (1919*a*). The results, however, are of such general interest, that I have acceded to numerous requests which have been made to me by entomologists to put them into a separate paper and to publish them where they may be most easily consulted by the largest number of students.

As a result of the study of the wing-venation already referred to, I was led to conclude that the family Micropterygidae (*s. lat.*) was in reality a superfamily consisting of three very distinct families, viz. the Micropterygidae (*s. str.*), the Eriocraniidae and the Mnesarchaeidae. The study of the mouth-parts, as will be seen here, fully bears out this conclusion, so that I now have no hesitation in speaking of the group as a superfamily, Micropterygoidea, containing the three families mentioned. Together with the superfamily Hepialoidea, which contains the four families Hepialidae, Prototheoridae, Anomosetidae and Palaeosetidae, the Micropterygoidea form the Suborder Homoneura of the Lepidoptera.

The following genera have been studied :—

Family MICROPTERYGIDAE :—*Sabatinca* Walk., *Micropteryx* Hübner.

Family ERIOCRANIIDAE :—*Eriocrania* Zeller, *Mnemonica* Meyr.

Family MNESARCHAEIDAE :—*Mnesarchaea* Meyr.

A large number of dissections of the head of various species of these five genera have been made, chiefly from

the same specimens used in my previous research on the wing-venation (1919*a*). These were all cleared in clove oil and mounted in Canada Balsam. Such mounts are excellent for the study of the labrum, mandibles and maxillae, but the softer portions of the labium and hypopharynx tend to shrivel. M. André Tonnoir, the well-known Belgian Dipterist, who is at present working at the Cawthron Institute, has kindly supplemented my material with some very fine dissections made by him recently and mounted in glycerine-gelatine. These mounts preserve the softer structures without any change or shrinking, and are much to be preferred for the study of the labium and hypopharynx. I wish to thank M. Tonnoir very much for the trouble he has taken in preparing this material for me. The drawings of thc labium and hypopharynx have nearly all been made from the mounts prepared by him.

It has seemed best to take each family separately and to describe the type of mouth-parts found within it carefully and fully first of all, and then to institute a comparison between the three families, and also between these and the Trichoptera, with a view to further elucidation of the problem of the origin of the Lepidoptera. The results of this paper will also be taken into account in writing the larger work now in course of preparation on the Mouth-parts of the Panorpoid Orders, which will form Part 4 of the "Panorpoid Complex."

Family MICROPTERYGIDAE.

In this family we have the two genera *Sabatinca* (N.Z.) and *Micropteryx* (Europe). Specimens of *Epimartyria* (N. America) have not been available for dissection, but this genus would appear to be very close indeed to *Micropteryx*. The genus *Micropardalis* Meyr. (1912, p. 7; N.Z., type *M. doroxena* Meyr.) is not sufficiently distinct from *Sabatinca* to be retained. Philpott (1922) has shown that the venational character on which this genus was based, viz. the possession of a complete R_1 in the hind-wing, is not present in the genotype, though it occurs in one species of *Sabatinca*, viz. *S. calliarcha* Meyr., while other species of the genus show varying amounts of reduction of this vein. As far as the mouth-parts are concerned, *Micropardalis* does not differ in any important detail from *Sabatinca*, and need not be further considered here.

Labrum-epipharynx.

(Text-fig. 1.)

In both genera, the *labrum-epipharynx* is a well-developed chitinous lobe, pentagonal in shape, as shown in Text-fig. 1. The upper part, or labrum proper, is separated from the lower part, or epipharynx, by a fairly wide blood-cavity. The epipharynx is remarkable for the development of asymmetrically placed chitinous structures carrying thick brushes of fine hairs, and working automatically in

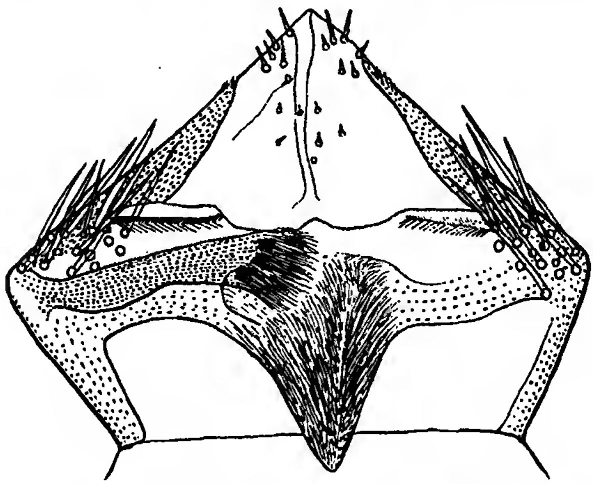


FIG. 1.—*Sabatinca aurella* Hudson (family Micropterygidae). Labrum-epipharynx (× 200).

connection with the movements of the mandibles. The labrum-epipharynx is attached to the clypeus along a broad base, the two sides adjacent to the base being considerably shorter, but the two distal sides much longer than these; each of the projecting angles measures about a right angle or a little more. From the right lateral angle, there is a chitinisation of the epipharyngeal membrane in the form of an arm running inwards nearly to the centre of the labrum, and carrying at its somewhat broadened end a stiff brush of numerous fine hairs. This brush works in contact with the apical concavity of the right mandible. There is also a weaker chitinised piece extending inwards from both lateral angles, a little basad from the line joining

them, and opening out medially into a large triangular area, whose apex projects backwards just over the clypeo-labral suture; the whole of this area carries a dense mass of fine hairs directed basad. This brush works in connection with both mandibles, being directly over the area of closure of their apical cutting and grinding surfaces.

There are two smaller chitinised ridges lying just distad of the line joining the two lateral angles; these carry only a row of very short, stiff bristles, whose function is not clear. The apical portion of the epipharynx is delicately membranous, and carries, especially on either side of the apex itself, only a few small and delicate sensory setae.

On the outer or labral side there is a strong chitinisation along the greater part of each distal side, exclusive of the soft membranous portion near the apex; on this is developed, around and above the lateral angle, a large patch of strong, stiff bristles of considerable size, the bristles being directed more or less towards the apex, and some of them reaching about half-way along the distal side.

The above description applies to both *Sabatinca* and *Micropteryx*, but the chitinisations in the latter genus are much stronger than in the former, and more densely pigmented. In *M. aruncella* Scop. the right lateral chitinous arm carrying the terminal brush is very dark in colour and very heavily chitinised, and extends apically into two sharp angles separated by a gentle convexity, from the whole of which the brush is developed. There is also considerable difference in the shape of the labium in the various species, that of *S. incongruella* Walk., for example, approaching the form of a regular pentagon by the lengthening of the two sides adjacent to the base.

As far as I am aware, the form of labrum found in this family is unique within the Insecta on account of the development of the asymmetrical brushes of hairs on the epipharynx and their functioning in conjunction with the very peculiar mandibles.

Mandibles.

(Text-fig. 2.)

The mandibles in the family Micropterygidae are remarkable in that, though present and functional in larval, pupal and imaginal stages, they show no similarity whatever in

any of the three stages. In the larva, they are of the ordinary strongly toothed biting type found in all Lepidopterous larvae; in the pupa, they become triangular in shape, running out distally into a long, sharp tooth, and are evidently fitted for the opening of the cocoon; in the imago, they remain fully functional, though reduced in size, and work in conjunction with the epipharyngeal and hypopharyngeal brushes and the triturating basket of the hypopharynx (described below) as grinders of the minute

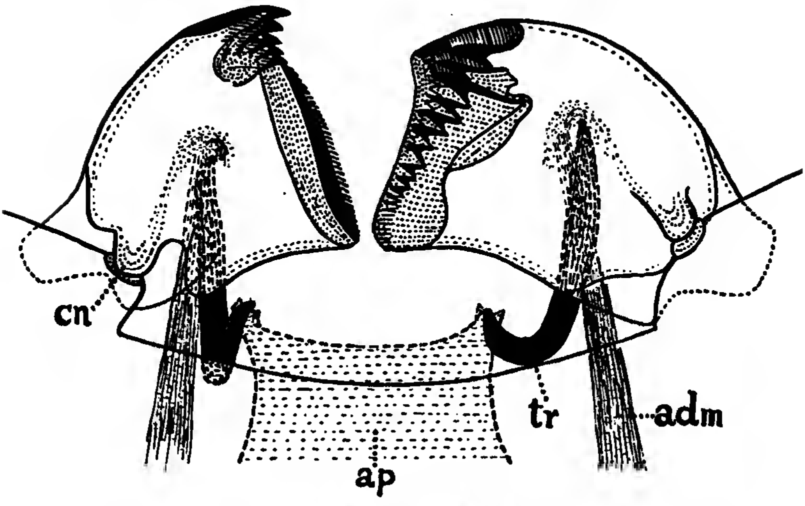


FIG. 2.—*Sabatinca incongruella* Walk. (family Micropterygidae). Mandibles, slightly separated by pressure of cover-slip (× 200). *adm*, adductor muscle of mandible; *ap*, fronto-clypeal apodeme; *cn*, condyle; *tr*, trabecula of hypopharynx. (The small abductor muscles are omitted.)

pollen grains or other fine vegetable matter which form the food of the imago.

In both genera, the structure of the mandibles is very much the same; the principal differences appear to be only of specific value, and consist merely in variations in the number and size of the teeth, or in slight differences in the general shape of the mandible. Text-fig. 2 shows the two mandibles of *Sabatinca incongruella* Walk., viewed from above, and slightly more separated than in their true positions owing to the pressure of the cover-glass. It will be seen that the right and left mandibles are strongly

dissimilar, but work together along the mid-longitudinal line of the mouth as a pair of grinding surfaces. In both mandibles the condyle is developed on the upper basal surface and is far removed from the edge. The distal faces of the mandibles are very different, that of the left mandible being in the form of a flattened grinding plate, finely serrated along its outer edge, with a small toothed area at its outer angle, carrying five teeth which decrease in size from the apex of the mandible inwards. The right mandible, on the other hand, has its distal face formed partially as a grinding surface, and partially to carry a nearly complete series of teeth, which are so set that their sharp points do not project beyond the general level of the grinding surface, but support it along the upper edge; these teeth increase in size from just beyond the inner distal angle, where they begin, up to the rather bluntly formed apex, where a set of three very large, sharp teeth stand close together against the edge of a curiously formed area, concave on the underside, which works in conjunction with the asymmetrical brush of hairs already described on the labrum-epipharynx. When the two mandibles meet together, the teeth around the apex of the left mandible work in the groove between these large teeth and this just-mentioned area, while the grinding face of the left mandible, which is obliquely bevelled, works also between the teeth and the grinding face on the right mandible. All these parts coming into close juxtaposition with one another, it follows that these mandibles form a most efficient triturating organ by themselves; but in conjunction with the triturating basket and the brushes of hairs on the labrum-epipharynx and hypopharynx, they can not only grind up the food into a mass of extremely minute particles, but also automatically mix it with saliva and work it up into a moist bolus suitable for swallowing. The actual manner in which the triturating basket itself is moved by means of the adductor muscles of the mandibles is explained below, in dealing with the hypopharynx.

Micropteryx aruncella Scop. differs from the above in having the apical teeth of the left mandible reduced to three or four in number, only two being at all prominent, and in having the series of teeth on the right mandible strongly formed distally by about five rather stout teeth along the outer half of the cutting face; but, from just beyond half-way, this dental series is represented only by

a denticulated ridge, in which the denticulations become more and more minute as the ridge approaches and finally reaches the inner distal angle of the mandible. This distal angle, moreover, appears to be more prominent and sharply formed than in *Sabatinca incongruella* Walk.

First Maxillae.

(Text-figs. 3, 4.)

In the Micropterygidae alone of all Lepidoptera the first maxillae are complete, being composed of cardo, stipes, a very long five-segmented palp situated on a short palpiger, and distinct galea and lacinia. The presence of the lacinia led Packard (1895) to raise them to a Suborder Lepidoptera Laciniata, as against the whole of the rest of the Order, Lepidoptera Haustellata. But the lacinia is already a very much reduced structure in these insects, though fully functional like the mandibles, and only a short step onwards in evolution is required to reach the stage shown in the Eriocraniidae, where the palp remains long, the galea begins to lengthen to form a haustellum, and the lacinia has disappeared. This is so obvious that few entomologists have adopted Packard's classification, and it is now no longer used.

The first maxillae of *Sabatinca* and *Micropteryx* are closely similar. Text-fig. 3 shows that of *Micropteryx aruncella* Scop. The cardo is a small, subtriangular piece, fairly strongly chitinised. The stipes is considerably larger, also subtriangular, but with the outer side convex. It is most strongly chitinised for about its basal four-fifths, the broader distal portion (forming, on the outer side, the small palpiger, and on the inner the bases of the galea and lacinia) being softer and much less deeply pigmented. The *maxillary palp* (Text-fig. 3, *p*) is very much longer than any other portion of the mouth-parts, being about 0·6 mm. long. The basal segment is slightly stouter than the next two, and the two distal segments taper gently to the sharply pointed apex. The first four segments are in ascending order as regards their lengths, the fourth being about two and a half times as long as the first. The fourth segment appears to be slightly flexible, and its distal two-thirds shows slight signs of very delicate and close annulation. The fifth or apical segment is very short, about three-

fourths the length of the basal segment; it is slightly fusiform basally, and tapers to a very sharp point apically.

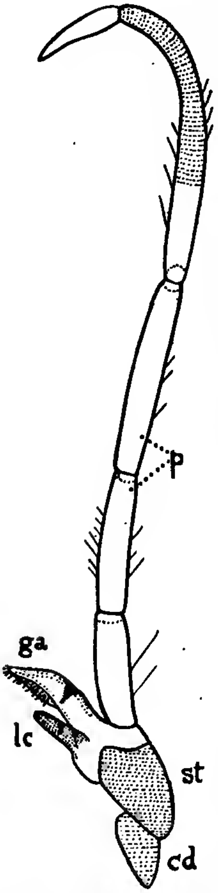


FIG. 3.—*Micropteryx aruncella* Scop. (family Micropterygidae) First maxilla (× 100). *cd*, cardo; *ga*, galea; *lc*, lacinia; *p*, palp; *st*, stipes.

The *galea* (Text-figs. 3, 4, *ga*) appears at first sight to be segmented; but this is due, not to actual segmentation, but to the development of a half-band of chitin supporting it basally on the outer side. It is about as long as the basal segment of the palp, but projects somewhat inwards away from the palp, with its rather pointed apex lying above and somewhat external to the base of the third segment of the labial palp. Apart from the supporting half-ring of strong chitin, it is very delicately chitinised; it is also of considerable thickness, and hence easily put out of shape when mounted. Its apex and inner edge both carry numerous delicately formed sensory setae.

The *lacinia* (Text-fig. 3, *lc*) is a short, rather bluntly pointed process, about half as long as the galea, and lying close above the basal portion of the internal edge of the latter. It is moderately strongly chitinised, with a slightly stronger half-band of chitin around its external side at about half-way. In its natural position, it lies vertically above the sensory process of the basal segment of the labial palp described below (see Text-fig. 4, *lc*).

In *Sabatinca chrysargyra* Meyr., the following slight differences may be noted from the above description:—In the maxillary palp, the second segment is slightly shorter than the first; the fourth segment is three times as long as the first, but shows no signs of annulation; the apical segment is short, about as long as the second, and much less sharply pointed than in *Micropteryx*. The lacinia is somewhat less blunt apically.

In *S. aurella* Hudson, the galea is distinctly blunter than in the above, but the lacinia ends in a sharp tooth or

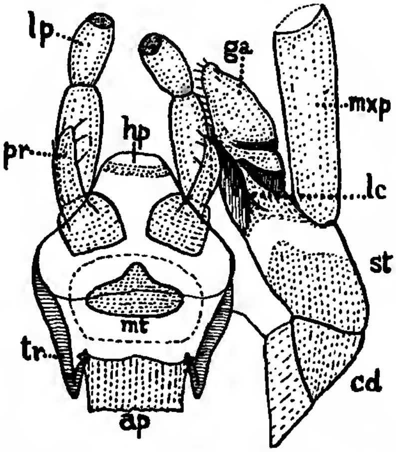


FIG. 4.—*Sabatinca aurella* Hudson (family Micropterygidae). Labium, hypopharynx and right maxilla (× 120). *ap*, fronto-clypeal apodeme; *cd*, cardo; *ga*, galea; *hp*, hypopharynx; *lc*, lacinia; *lp*, labial palp; *mt*, mental plate; *mxp*, maxillary palp; *pr*, chitinous process from first segment of labial palp; *st*, stipes; *tr*, trabecula.

hook (Text-fig. 4, *lc*). There are two distinct half-bands of chitin on the galea, one near the base and a second narrower one about half-way.

Labium and Hypopharynx.

(Text-figs. 5–7.)

Though actually quite distinct in origin and structure, the labium and hypopharynx are so closely in contact in the imaginal mouth that it is best to consider them together. The hypopharynx lies above the labium, and is developed as a lobe formed from the floor of the pharynx, which continues forwards as a short projecting tongue. The lower surface of this tongue unites with the upper membrane of the labium in the region of the opening of the common salivary duct, *i. e.* above the mental plate. The upper surface is continued backwards as the floor of the mouth, as far as the opening of the oesophagus, which is situated

just under the fronto-clypeal apodeme, a chitinous plate projecting internally from the suture separating the frons from the clypeus.

In some primitive insects, the hypopharynx supports, on either side, a small process which sometimes resembles a true appendage. This pair of processes has been homologised with the maxillulae of Crustacea by Hansen and Carpenter, and with the paragnaths of Crustacea by Crampton. As these structures are not present in any Micropterygoidea, they need not be discussed here.

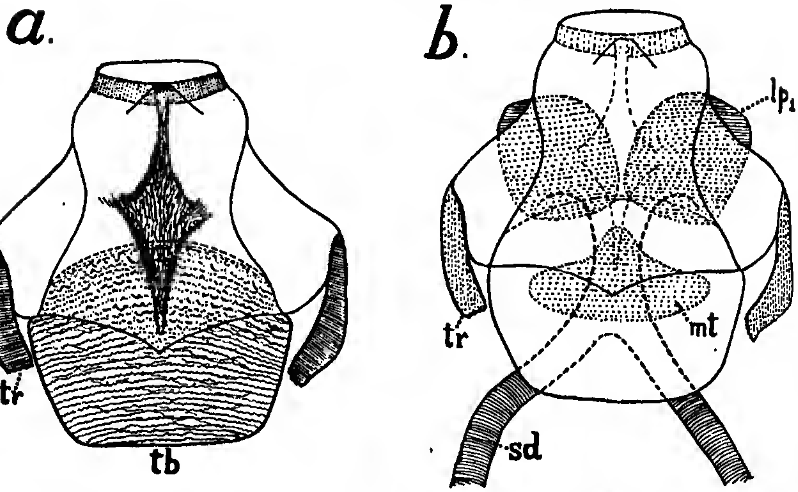


FIG. 5.—*Sabatinca aurella* Hudson (family Micropterygidae). Hypopharynx (× 167). *a*. Hypopharynx viewed from above. *b*. Outline of same, showing position of salivary ducts, *sd*, and of the mental plate, *mt*, and first segment of palp, lp_1, of the labium. *tb*, triturating basket; *tr*, trabecula, cut off short.

The hypopharynx in the Micropterygidae is a highly specialised organ, evolved for the purpose of triturating the food, in conjunction with the mandibles and labrum-epipharynx. It is supported on either side by a strongly curved chitinous piece, the *trabecula* (Text-figs. 5, 7, *tr*). Each trabecula is freely articulated basally with a short process from the lateral angle of the fronto-clypeal apodeme, as shown in Text-fig. 2. Each trabecula is also attached by a small ligamentous piece to the adductor muscle of the mandible on the same side, so that the same muscles which close the mandibles also work the hypopharynx. Viewed from above, *i. e.* looking down on to the floor of

the mouth (Text-fig. 5), the hypopharynx appears as a broad, tongue-like lobe of soft membrane, broadest at the distal ends of the trabeculae, and narrowing distally to its strongly truncated and somewhat upturned apex. This apical portion is oval in transverse section, and is supported on its lower side by a half-ring of chitin. Basad from this area, the hypopharynx widens out below to the distal ends of the trabeculae; but above, it swells out convexly for a short distance only, and then narrows in to form a slight waist, just above and well inwards from the ends of the trabeculae. From this waist, it again broadens out towards the trabeculae. The whole of the upper surface of the hypopharynx then turns sharply under, forming a sharp ridge, and is then bent backwards towards the apex and downwards to form the distal wall of a large concave chamber, the *triturating basket* (Text-figs. 5*a*, 7*b*, *tb*), which curves round basad between the two trabeculae, and is supported by them. The inside lining of this basket is thrown into delicate transverse folds, minutely denticulated, with the denticles directed basad, *i. e.* towards the gullet.

In their natural positions, the small mandibles lie above the triturating basket, and their distal grinding edges meet above it in the middle line. There is a very curious arrangement whereby the whole basket works in conjunction with the two mandibles, being actually moved by means of the mandibular adductor muscles. The trabecula is attached on its outer side to a membrane, which is also connected with the mandible itself along the edge of the chitinised depression at the end of which the adductor muscle is attached. At a point about half-way along the trabecula, the adductor muscle is nearly in contact with it; and just at this point there is a small hardened ligamentous piece, by means of which an actual attachment of the muscle to the trabecula is formed; so that the trabecula, as well as the mandible, is moved backwards and forwards by this muscle. Thus it is clear that, when the two mandibles are adducted, the basket is contracted longitudinally with them; and when the mandibles are separated, the basket again returns to its normal shape. Thus the basket is not a mere passive instrument, but truly a part of the triturating apparatus, and well merits the name which I have here given it.

On the upper surface of the hypopharynx, extending from near the apex right back almost to the overlapping

upper edge of the basket, there is developed a large diamond-shaped patch of fine, stiff hairs, all directed backwards (Text-fig. 5*a*). This patch of hairs works in conjunction with the triangular patch of hairs on the epipharynx. The two patches, pressing fairly closely together, and all directed backwards towards the gullet, effectually prevent any of the triturated particles from passing forwards and escaping out of the mouth. The distal end of the patch lies on a small, slightly prominent, conical projection, just above the apical chitinous half-ring.

Text-fig. 5 *a* shows the above structures of the hypopharynx *in situ*. In Text-fig. 5 *b* I have outlined the hypopharynx, and shaded in the mental plate and two basal segments of the palpi belonging to the labium beneath it, in order to show exactly the course of the *salivary ducts* (*sd*). These ducts lie in the hypopharyngeal cavity, and are wide apart at the level of the basal border of the basket. Passing beneath the basket, they approach rapidly, and fuse together into a short *common duct*, which opens, as already stated, by a wide mouth, on the lower surface of the hypopharynx just above the bases of the first segments of the labial palpi.

The *labium*, as in all Lepidoptera, has its parts reduced, except only the palpi. The floor of the labium is membranous, and carries only a single plate, which I have called the *mental plate* (*mt*); it may represent the mentum, or perhaps the mentum and submentum fused together. In shape this plate may be described as subtriangular, with its elongated and transversely placed base convex, its rounded apex directed forwards, and the two equal sides slightly concave; all three angles are well rounded. The two *palpi* are comparatively large, and are inserted very close together on the front border of the membrane, distad from the mental plate. Each palp is three-segmented (Text-fig. 6). The basal segment is short and broad, strongly chitinised below, and carrying numerous strong setae, short and stiff on the inner portion, but many of them greatly elongated on the outer portion; some of the longest reach as far as the apex of the second segment. Between the first and second segments there is a considerable area of soft sutural membrane. The second segment is narrower, about twice as long as wide, heavily chitinised, and carrying numerous setae, none of which are exceptionally elongated; its inner border is straight, its outer border

convex. The third or distal segment is oval in shape, slightly shorter than the second, and is also well chitinised and armed with setae. The apex of the third segment

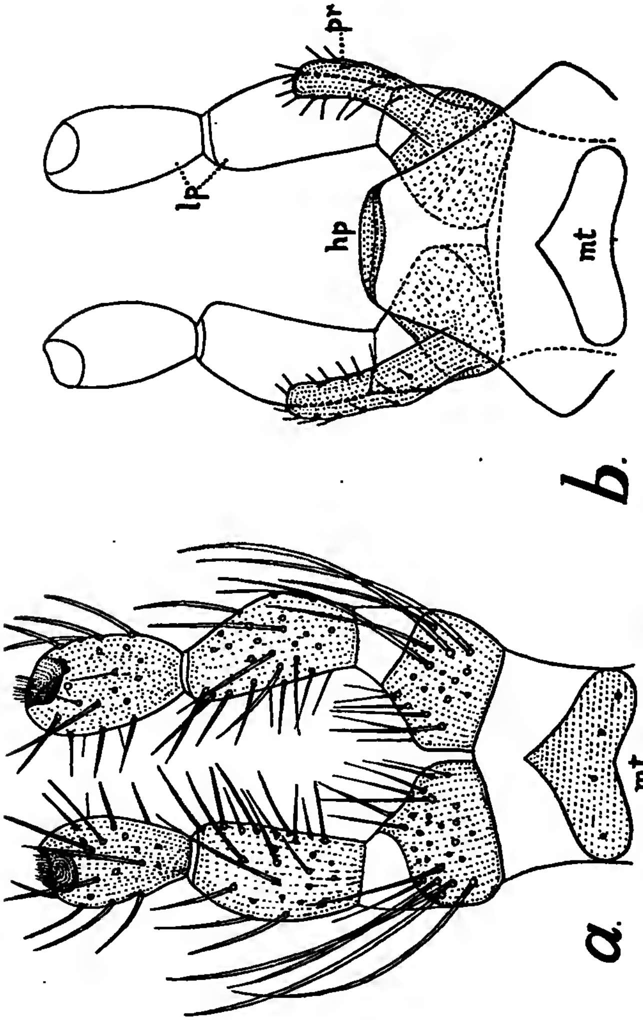


FIG. 6.—*Sabatinca incongruella* Walk. (family Micropterygidae). Labium (× 167). *a.* Viewed from beneath. *b.* Viewed from above in outline, except only the first segments of the palpi, which are shown in full with their chitinous processes, *pr*, in position; the hypopharynx, *hp*, is drawn in position above the labium. *lp*, labial palp; *mt*, mental plate, in outline.

carries a deep cup-like depression whose edge is furnished with some fine sensory setae (Text-fig. 5). It is probably a glandular organ, but its function is unknown. Possibly it may secrete a sticky substance by means of which the

insect may be enabled to gather the pollen-grains, spores, etc., which form its food.

The most interesting structure on the labial palpi is a pair of *sensory processes* (Text-figs. 5, 7, *pr*), of a delicate membranous nature, not unlike the maxillary galea in structure, and carrying delicate sensory setae; these are developed as outgrowths from the upper surface of the basal segments, *i. e.* the surface just below the hypopharynx and just in front of the opening of the salivary duct. Careful preparations in gelatine-glycerine and in chloral-phenol show that these processes are undoubtedly attached, without jointing, to this region of the basal segments of the labium; they project forwards above and slightly external to the palpi themselves, and their apices lie directly beneath the apices of the maxillary laciniae and the inner border of the galeae. It would seem probable that the chief function of these processes, and of the galea and lacinia also, may be to collect the saliva and spread it over the food during trituration. There being no ligula present, it is easy to see that, unless some such function as this is admitted, the saliva could not be carried into the mouth at all.

It is quite clear from the original descriptions of Walter (1885) and Packard (1895) that both these authors regarded these processes as being the paraglossae (malae externae) of the labium, while the hypopharynx was considered to correspond with the fused glossae (mala interna). A full quotation of Walter's original description as translated by Packard need not be given here. Although the description itself is somewhat involved, and not easy to understand, it is quite clear that, while the three segments of the labial palp were correctly determined, the authors made a serious error in imagining that the "chitinous leaves," which is the name used for the sensory processes of the first segment of the palpi, were attached, not to the palp, but to the hypopharynx, which they considered to be the inner lobe of the labium (mala interna) or fused glossae. Consequently they homologised these processes with the paraglossae or malae externae. The description of the portion of the supposed mala interna which they take to be the true hypopharynx is so fanciful as to baffle interpretation, and the reference to appendages or teeth on its edge does not seem to be supported by anything beyond an effort of imagination. No mention is made of the salivary ducts,

and no attempt made to find out their position. If this had been done, the error in assuming the true hypopharynx to be the mala interna of the labium would at once have been apparent. Walter's conclusion of the account is as follows :—

"We have here in opposition to the weak naked underlip represented by a triangular plate in other Lepidoptera a true ligula formed by the coalescence of the inner lobes of the second maxillae into a tube, as in many Hymenoptera, and with free external lobes which correspond to the paraglossae of Hymenoptera."

In Text-fig. 7 I have compared the lateral views of the

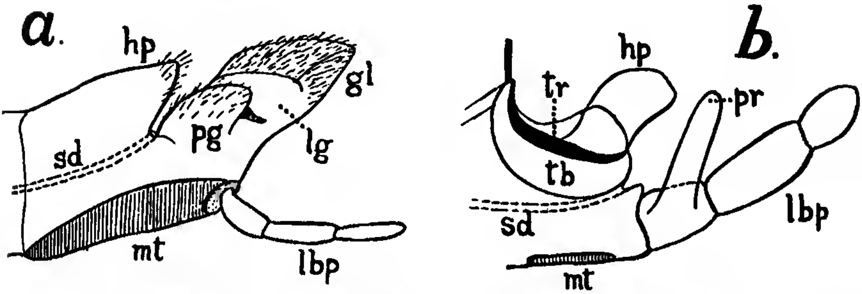


Fig. 7.—Diagrammatic lateral views of the labium and hypopharynx in *a*, a Hymenopteron, *Paniscus* sp. (fam. Ichneumonidae), and *b*, a Micropterygid. The opening of the salivary duct separates the hypopharynx (above) from the labium (below). Note the complete absence of the ligula in *b*. In *a*, the ligula, *lg*, consists of a large median lobe formed from the two glossae combined, *gl*, and a pair of shorter lateral lobes or paraglossae, *pg*. *hp*, hypopharynx; *lbp*, labial palp; *mt*, mental plate; *sd*, salivary duct; *tb*, triturating basket; *tr*, trabecula.

hypopharynx and labium of the Micropterygidae with that of an Ichneumonid, *Paniscus* sp., in which the ligula is not unlike that found in the short-tongued bees. Any further comment upon this matter would seem to be superfluous.

Family ERIOCRANIIDAE.

Four genera are known in this family. Two of these, *Neopseustis* Meyr. and *Acanthopteroctetes* Braun, are exceedingly rare, and not available for study. This leaves the two well-known genera *Eriocrania* Zeller and *Mnemonica* Meyr., the former being simply a specialised offshoot of the latter by the loss of one terminal vein in the fore-wing.

As far as their mouth-parts are concerned, the two genera do not differ in any important particular. The results here given have been obtained by dissections of the mouth-parts of *Eriocrania semipurpurella* Steph.

In comparison with the Micropterygidae, the Eriocraniidae show a considerably more highly specialised mouth, definitely of the haustellate or sucking type; but at the same time still possessing sufficient archaic characters to allow of its being recognised as evolved from a primitive mandibulate type similar to that found in Micropterygidae, though without the specialised basket apparatus of the hypopharynx.

Labrum-epipharynx.

(Text-fig. 8.)

This is present in *Eriocrania* as a small, broad, bellows-shaped lobe, the upper or labral surface carrying a number of elongated scales, which project forward in front of it,

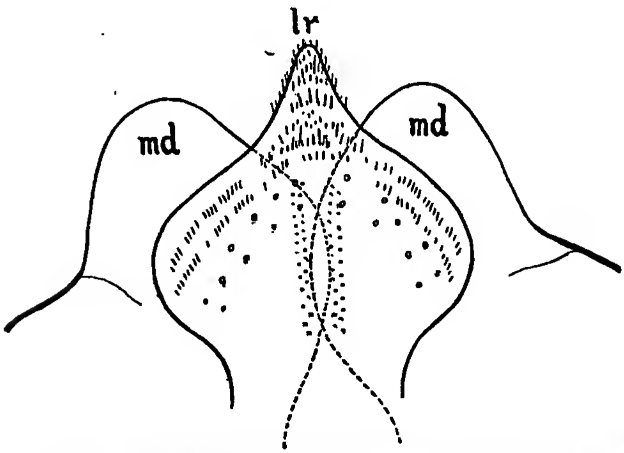


Fig. 8.—*Eriocrania semipurpurella* Steph. (family Eriocraniidae). Labrum-epipharynx and mandibles (× 200).

while the lower or epipharyngeal surface carries numerous minute sensory setae arranged more or less irregularly in two rows near the margins, and with two double rows of minute taste-buds lying one on each side and very close to

the mid-longitudinal line. In the natural position, this lobe covers the extreme bases of the galeae from above, and also overlies the inner portions of the two non-functional mandibles, as may be seen from Text-fig. 8.

Mandibles.

(Text-fig. 8.)

It has been generally stated that mandibles are absent in this family; but this statement is not true. The mandibles are present as small but very distinct rounded lobes, with broad bases, lying on either side of, and partly underneath, the small labrum, and with their inner edges slightly overlapping in the middle line. They somewhat resemble the obsolescent mandibles to be found in certain Trichoptera, but are rather more strongly chitinised than is usual in that Order. They are obviously non-functional, having lost both their adductor and abductor muscles, and no longer having a condyle or being in any way movably separated from the head-capsule. They are entirely devoid of teeth, sculpture or sensillae.

First Maxillae.

(Text-figs. 9, 10.)

In this family the first maxillae retain the long five-segmented palpi found in the Micropterygidae, but the lacinia is entirely absent. The galea is lengthened into a softly chitinised, strongly curved and pointed organ with a longitudinal groove on its inner side. The two galeae unite together to form a single sucking-tube or *haustellum*, capable of a certain amount of coiling up. The extreme base of the galea is heavily chitinised and strongly convex externally, as shown in Text-fig. 9, so that, when the two galeae are acting together, the base appears somewhat bulbous. From a little beyond this point right to the tip the galea is delicately ribbed transversely, and the margins very finely serrated, as is usual in Lepidopterous haustella.

The *maxillary palp* carries numerous scales of various shapes, together with some small, slender setae. The first segment is fairly long, and somewhat stouter than the others. The second segment is shorter and narrower than

the first; the third is slightly longer than the first, and intermediate in width between the first and second. The fourth segment is very long, more than twice as long as the second, and increasing in width slightly towards the apex. In *Eriocrania semipurpurella* Steph. there is a darkly pigmented portion occupying about a fourth of its length,

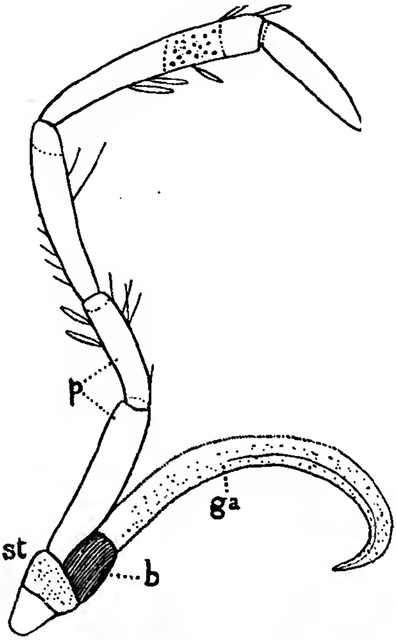


FIG. 9.—*Eriocrania semipurpurella* Steph. (family Eriocraniidae). First maxilla (× 100). *b*, hardened convex base of galea; *ga*, galea; *p*, palp; *st*, stipes. Scales and hairs mostly removed.

not far from the apex. The fifth or apical segment is about as long as the first, but narrower, with a moderately pointed apex.

The stipes can be recognised as a small, rather broad, slightly chitinised area from which both galea and palp spring. The cardo is not clearly defined as a separate sclerite, but is probably represented in the lightly chitinised area which lies just below the stipes and just forward and external to the gular plate on either side.

Labium and Hypopharynx.

(Text-figs. 10, 11.)

As in all other Lepidoptera, the labium is reduced to a small basal piece, or *mental plate* (*mp*), carrying large, three-segmented palpi (*lbp*). This plate is somewhat heart-

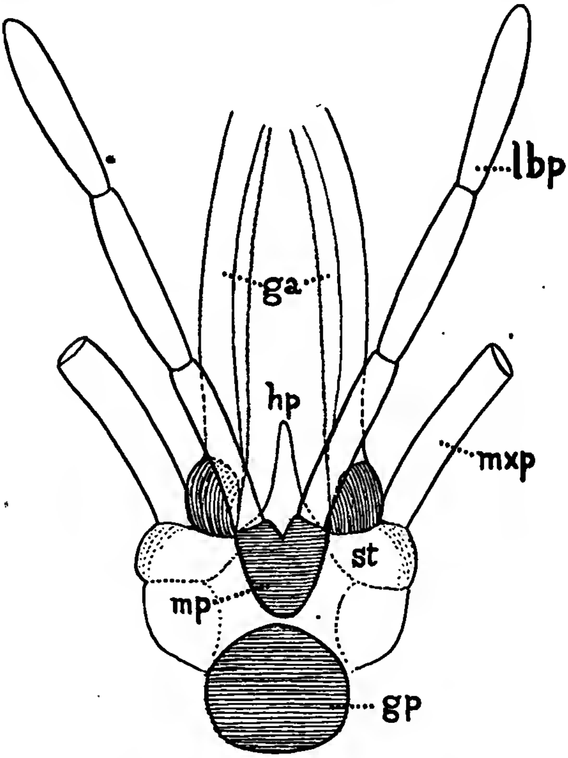


Fig. 10.—*Eriocrania semipurpurella* Steph. (family Eriocraniidae). Labium, hypopharynx and maxillae (× 120). *ga*, galeae; *gp*, gular plate; *hp*, hypopharynx; *lbp*, labial palp; *mp*, mental plate; *mxp*, maxillary palp; *st*, stipes. Scales and hairs removed.

shaped, but is notched in the middle in front, so as to become divided into two short lobes, each of which carries one of the labial palpi. There is no separate submentum. The *gular plate* (*gp*) is a very distinct, heavily chitinised, oval plate, lying well behind the mentum, and separated

from it by membrane only; it is considerably larger than the mentum. The *labial palpi* (*lbp*) arise close together from the mentum, and diverge strongly from one another. Each is composed of three very nearly equal segments of slender cylindrical shape, the apex of the distal segment being bluntly rounded. The palpi are clothed with delicate hairs and narrow scales, which are longer but not so numerous as those found on the maxillary palpi.

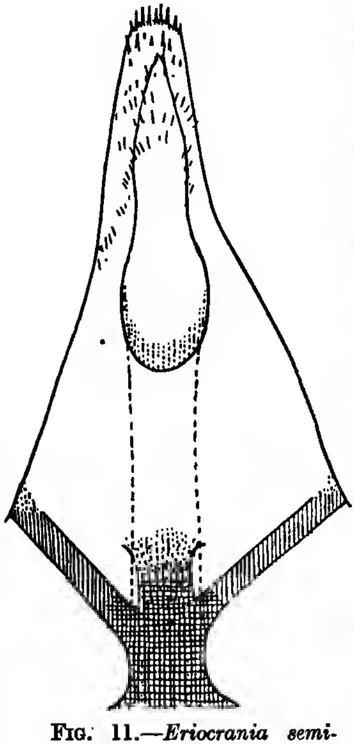


FIG. 11.—*Eriocrania semipurpurella* Steph. (family Eriocraniidae) Hypopharynx (× 400).

The *hypopharynx* (Text-figs. 10, *hp*, and 11) is not easy to find, but is present as a small, tongue-like lobe, projecting outwards from above the mentum between the bases of the two galeae. Its length is little more than half that of the first segment of the labial palp. In shape it is narrowly triangular. It is a hollow organ, having its upper surface supported basally on either side by two arms which arise from the fronto-clypeal apodeme. In front of these arms, the membrane of the upper surface continues for some distance, but ends before reaching the narrower distal portion, leaving a small but distinct oval opening on the upper surface, which is continued forward as a kind of slit between the slightly overfolded edges of the distal part of the tongue. Thus it appears that the true opening of the oesophagus into the pharynx has become moved forwards from its original position under the fronto-clypeal apodeme, and is carried out on to the upper surface of the hypopharynx. The reason for this is clear when it is seen that the hypopharynx closes the small cavity between the galeae beneath, at their bases, and so the tube of the haustellum passes backwards, without any discontinuity, into the

backward prolongation formed in the hypopharynx, and from thence, under the fronto-clypeal apodeme, into the true oesophagus. Thus the sucking apparatus, formed primarily by the two galeae, is completely closed both above and below by the utilisation of the much-reduced, but still functional, labrum-epipharynx and the hypopharynx.

The hypopharynx is only lightly chitinised, and carries numerous delicate sensory setae on its distal portion, especially around its slender apex. Careful search has failed to disclose any salivary ducts in connection with it.

It is not possible to derive this type of hypopharynx from the very highly specialised type found in Micropterygidae, but it is clearly quite easily derivable from a slightly more primitive Orthopteroid type of tongue having a concave upper surface provided with sensory setae. The triturating basket of the Micropterygidae is also derivable from the same Orthopteroid type by deepening of the concavity and specialisation in function, with development of movable trabeculae.

Family MNESARCHAEIDAE.

(Text-fig. 12.)

This family only contains one genus, *Mnesarchaea* Meyr., with four species confined to New Zealand. The type of mouth-parts is very similar to that found in some of the Tineoidea. The size of the mouth is greatly reduced, the labrum being only a very small triangular flap lying above and between the bases of the two galeae. There are no mandibles. The *first maxillae* have a small triangular cardo and well-developed stipes, from which springs the long, curved *galea* (*ga*), grooved on its inner side. This galea is more than half as long again as the labial palp. The two galeae evidently form together a primitive haustellum, capable of being coiled up when not in use, and forming a fairly effective sucking-organ. Attached to the outer distal part of the stipes is the much-reduced *maxillary palp* (*mxp*); this is formed of three short segments of about equal size, the length of the whole palp being little more than that of the second segment of the labial palp, and much more slender. This small palp carries a moderate number of scales.

The *labium* has a short, wide mentum (*mt*), with the distal margin slightly concave medially. The two *palpi* (*lp*)

arise wide apart from the two lateral angles of the distal border of the mentum, and diverge strongly, as in Eriocraniidae. They are stout, strongly formed organs, completely hidden in the very numerous large scales which they carry all over each segment. Each palp consists of three segments, of which the basal one is short, little longer

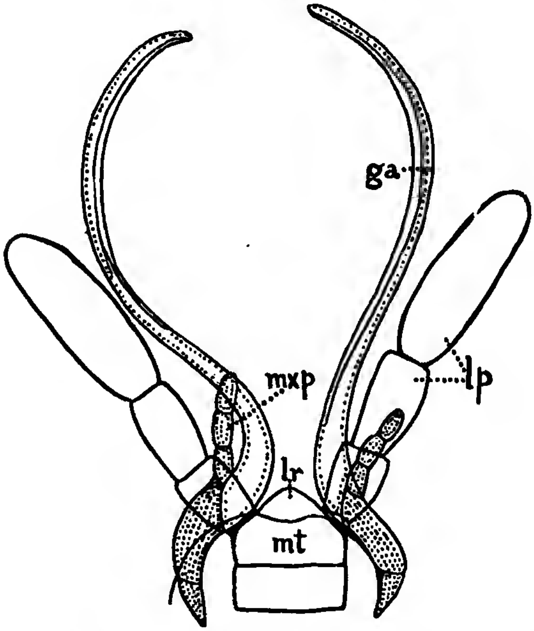


Fig. 12.—*Mnesarchaea paracosma* Meyr. (family Mnesarchaeidae). View of mouth-parts, slightly flattened down by cover-slip. *ga*, galea; *lp*, labial palp; *lr*, labrum; *mxp*, maxillary palp (× 120). Scales removed.

than broad, the second about a third longer than the first, and the third twice as long as the second. The first two are subcylindrical in shape, the third elongate oval, with very rounded apex. No definite hypopharynx can be made out, nor can I find any sign of the salivary ducts.

Comparison of the three Families.

From the above study, we see that the three families forming the Micropterygoidea are quite as distinct as regard their mouth-parts as they have also been shown to be in their venation. The most archaic family is undoubtedly the Micropterygidae, which have functional mandibles, com-

plete first maxillae, and well-developed labrum-epipharynx and hypopharynx, but in which, contrary to the accepted view based on Walter and Packard, the labium is already specialised by the loss of its ligula. This is a very important point, as I am able to state that, throughout the whole of the Orders of the Panorpoid Complex, the ligula is never well developed as it is in typical Orthopteroid insects, and never consists of chitinised glossae and paraglossae. The most primitive ligula within the group is to be found in certain Neuroptera only, where it forms a small but definite membranous lobe, sometimes bifid at the tip. The importance of this point will be apparent when the question of the origin of the proboscis in Diptera has to be considered.

Greatly in advance of the Micropterygidae stand the Eriocraniidae, owing to the loss of functional mandibles, here represented only by non-functional chitinous lobes, by the reduction in size of the mouth, reduction and specialisation of the labrum-epipharynx, reduction of the hypopharynx, loss of the maxillary lacinia, and specialisation of the galeae to form a true haustellum. The family is, however, archaic in still retaining the large, five-segmented maxillary palpi, of closely similar form to those of the Micropterygidae.

In the Mnesarchaeidae, specialisation has gone a further stage, resulting in the Tineoid type of mouth-parts, in which, in addition to the specialisations already mentioned for Eriocraniidae, the labrum is now reduced to a mere flap, the non-functional mandibles are eliminated, no true hypopharynx is recognisable, and the maxillary palpi are greatly reduced and only three-segmented.

Relationships of the Micropterygoidea with the Order Trichoptera.

In the Trichoptera, the mouth-parts are specialised by the absence of functional mandibles—these organs being at the most mere flaps—by the loss of the maxillary lacinia and reduction of the galea, and by the reduction of the labium to a small mental plate, without any definite ligula. Maxillary and labial palpi, however, remain primitive and well developed, the former having five and the latter three segments. The labrum is well developed, and there is also generally a definite, functional hypopharynx, with salivary ducts.

Comparing this Trichopterous condition with the three

types found in the Micropterygoidea, we are able to place it at once, in the scale of evolution, as lying between that of the Micropterygidae and that of the Eriocraniidae. The latter are more specialised than the Trichoptera in having the galeae already forming a short haustellum, and the hypopharynx greatly reduced. The Trichoptera, however, are more specialised than the Micropterygidae in no longer possessing either functional mandibles or laciniae, and in the reduced size of the mouth by comparison. All three types agree in the possession of the two pairs of primitive palpi.

It is thus clear that we cannot derive the Order Lepidoptera from the Order Trichoptera on the evidence of the mouth-parts; for the former do not possess the fully developed mouth and functional mandibles which are found in the Micropterygidae. This conclusion reinforces that already arrived at on the evidence of the wing-venation (Tillyard, 1919).

Is it possible, on the evidence of the mouth-parts, to derive the Trichoptera from the Micropterygidae? The answer to this must also be in the negative. For, although the Trichoptera undoubtedly came from Micropterygid-like ancestors in which the mouth was complete, with functional mandibles, and perhaps also with laciniae, yet they most certainly did not possess the extraordinary specialisations of the parts which are developed in the Micropterygidae for the triturating of the food. Had they done so, it is scarcely conceivable that they should have again lost them without leaving a trace of evidence behind. This conclusion is again in agreement with the evidence offered by the wing-venation.

We have, therefore, to conclude that the Lepidoptera are not descended from the Trichoptera, nor are the Trichoptera descended from the Micropterygidae, but both Orders are descended from a common ancestral stem which combined the archaic characters common to both, but was evidently terrestrial in its life-history. This common stem, as the fossil evidence clearly shows, was itself derived from the ancestral forms common to it and the Diptera, viz. the Paramecoptera of the Upper Permian, which were intermediate in structure between the Mecoptera, on the one hand, and the Neuroptera on the other—both these latter Orders being already differentiated off at that period.

This paper may be profitably concluded by giving a Table of the Characters of the Mouth-parts for the three

families of the Micropterygoidea and for the Archetype of the Trichoptera, with calculations of the percentage of archaic characters in each case, 100 representing an Orthopteroid type with complete mandibulate mouth-parts :—

TABLE OF THE CHARACTERS OF THE MOUTH-PARTS FOR THE MICROPTERYGOIDEA AND THE ORDER TRICHOPTERA

Ref. No.	Character.	Micropterygidae.	Eriocraniidae.	Mnesarchaeidae.	Trichoptera.
1.	Labrum-epipharynx :— A, complete; B, reduced.	A	A	B	A
2.	Mandibles :— A, functional, full-size; B, functional, reduced; C, non-functional, reduced; D, absent.	A	C	D	C
3.	Maxillary Palpi :— A, full-size, 5-segmented; B, reduced, 3-segmented; C, absent.	A	A	B	A
4.	Galea of Maxilla :— A, normal, with sensillae; B_1, haustellate; B_2, reduced, without sensillae.	A	B_1	B_1	B_2
5.	Lacinia of Maxilla :— A, present; B, absent.	A	B	B	B
6.	Hypopharynx :— A, full-size, normal; B, full-size, specialised; C, reduced; D, absent.	B	C	D	A
7.	Labial Palpi :— A, full-size, 5-segmented; B, reduced; C, absent.	A	A	A	A
8.	Ligula of Labium :— A, normal, full-size; B, reduced; C, absent.	C	C	C	C
	Percentage of archaic characters :—	83·3	56·3	31·3	64·6

N.B.—In calculating the above percentages, where a character is represented only by A or B, A scores 1, B nil; where it is represented by A, B or C, A scores 1, B $\frac{1}{2}$, C nil; where it is represented by A, B, C or D, A scores 1, B $\frac{2}{3}$, C $\frac{1}{3}$, D nil. Thus the total for the Micropterygidae is $6\frac{2}{3}$ out of 8, or 83·3 per cent., and so on.

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VIII. *Records and Problems of Insect Migration.*

By C. B. Williams, M.A., F.E.S.

With Three Text Figures.

[Read March 21st, 1923.]

In a series of three previous papers (Trans. Ent. Soc. 1917, p. 154; 1919, p. 76, and 1920, p. 146) I have published records of insect migrations that I have observed or that have been reported to me, and the first part of the present paper is a continuation of this policy of making available to all students as many as possible of the facts on which any theories must be based.

L. D. Cleare has been able to supplement considerably my records from British Guiana (Trans. Ent. Soc. 1921, p. 331), and more recently Prof. Poulton has brought forward some interesting records from other parts of the world, and has made some interesting suggestions (Proc. Ent. Soc. 1921, p. v, and pp. xii–xxvii).

In view of the increased interest which seems to have been aroused in this subject—which after all is one of fundamental importance and intense fascination—I have devoted the second part of this paper to a discussion of the various problems connected with migration, and a critical examination of some of the theories that have been put forward, in order to see how far they fit the few facts already known.

Although the final result is still inconclusive, I think that the outline will be useful in pointing out what class of information is still needed in order to settle some of the outstanding problems, and also that it may lead to this information being produced—by someone or other—sooner than might otherwise occur.

If some friendly critic remarks that my own records in the first part do not come up to the standard demanded in the second part, I would point out that it is only quite recently that the possible importance of certain factors has been recognised, and secondly that even incomplete information, if reliable, is of some value, provided only that its incompleteness is kept in mind, for a theory that

is expected to fit all the facts must all the more fit part of them.

There is also another reason for publishing incomplete and often quite casual records, and that is that they indicate to other observers localities where migrations may be expected to occur, and species that should be specially watched.

Part I.

The following migrations are described or discussed :—

I. *Catopsilia statira* in British Guiana, a correction.
II. *Catopsilia* spp. in Costa Rica.
III. *Catopsilia statira* in large flocks in Venezuela.
IV. White and Yellow Butterflies in Malay Peninsula.
V. White butterflies at Nairobi, Kenya Colony.
VI. *Vanessa cardui* in Mediterranean in 1921.
VII. *Vanessa cardui* in Palestine in 1922.
VIII. *Vanessa cardui* in Egypt.
IX. *Agrotis upsilon* in India and Egypt.
X. *Cydamon leilus* in Trinidad.

I. *Catopsilia statira* in British Guiana.

On p. 155 of the Trans. Ent. Soc. for 1917 I described a migration of *Catopsilia* (*Callidryas*) *eubule* at Issororo, British Guiana. In recording the migration as this species I accepted a local determination, and sent home all my specimens in papers. When I returned to England in 1921 I examined the specimens again and found that all taken from this migration were *Catopsilia statira* and not *C. eubule*.

II. *Catopsilia* spp. in Costa Rica.

Mr. A. Hall kindly allows me to record the following observations from his note-book.

On the 19th October, 1904, when on the Costa Rica railway between the stations of Zent and Swamp (a few miles from Port Limon on the Atlantic coast), he noticed "great quantities of butterflies of the genus *Catopsilia*. They came along the track in great numbers, generally several at a time, and as they were practically all flying in the same direction there would seem to have been some sort of a migration. The great majority were males of

C. statira, but with them were a fair number of *C. argante* and a very few *C. boisduvalli*. In the afternoon they were all flying in exactly the opposite direction in much smaller numbers." Mr. Hall adds: "Although I have no definite record of the direction of the flight I distinctly recollect that they were going towards the sun, that is to say, east in the morning and west in the afternoon."

The coast at this part runs from north-west to south-east, so that they were flying diagonally towards it in the morning and away from it in the evening.

III. *Catopsilia statira* in large flocks in Venezuela.

Mr. A. Hall also provides the following record.

"One day in September 1920 I saw immense numbers of *C. statira* settling on the sands along the river bank at San Esteban in Venezuela. There was one patch that I estimated to contain over two thousand specimens (I put my net over forty-seven at once) and several smaller patches near by. I saw no tendency to migrate, but when I returned to the same spot two days later there were only a few odd specimens about."

IV. Pierids migrating in Kenya Colony.

Dr. A. Jex-Blake of Nairobi, Kenya Colony, in a letter to Dr. P. A. Buxton on the 19th February, 1921, writes:—

"All this month we have had droves and droves of white black-veined butterflies going westward with the prevailing wind; one can see many hundreds at a time drifting across our garden—say over an acre—and this may go on for hours. We met similar droves at Nyeri, a hundred miles away, and coming along the road would have two or three going diagonally across the front seat of the car at a time, so thick the flocks of them were in places. Then locally one finds droves of small orange-tips or droves of small yellow butterflies."

V. White and Yellow Butterflies in the Malay Peninsula.

Mr. J. L. Humphreys gives me the following note on a migration that he observed near Malacca, Straits Settlements, in June 1908. It was about 10 a.m., and a continuous stream of white and yellow butterflies were flying

in a north-westerly direction along about one and a half miles of road near the sea. There were millions of the butterflies, and on inquiry Mr. Humphreys was told that, according to the natives, the butterflies were flying to Mecca! The direction of the wind was not noted.

VI. *Pyrameis cardui* in the Mediterranean.

On the 4th July, 1921, when on a voyage from Trieste to Alexandria, I observed a number of butterflies migrating

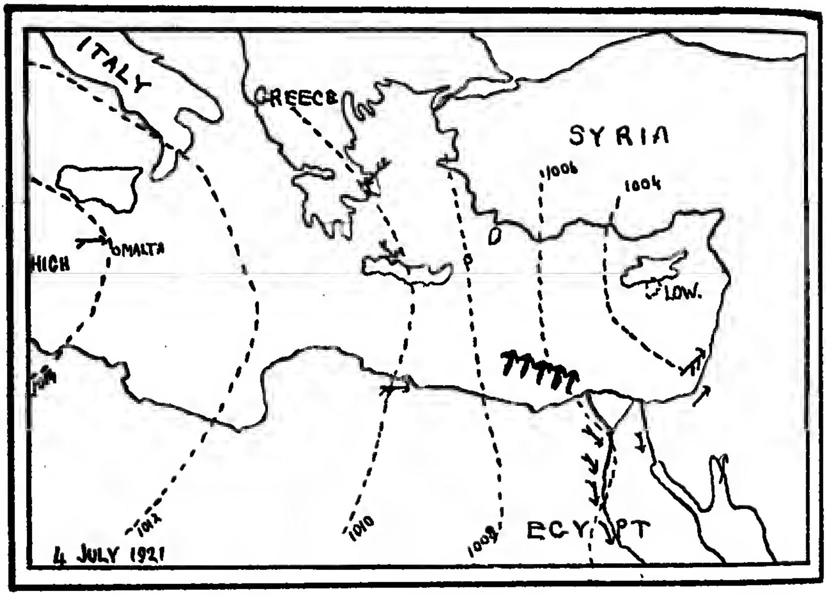

FIG. 1.

from south to north across the Mediterranean from Egypt to Greece or Syria as follows.

The first butterfly was noticed at 9.30 a.m. when our steamer was about three-quarter way from the south-west corner of Crete to Alexandria; that is to say, approximately in latitude 32·30 N. and 28 E. longitude. We were about seventy miles north of the coast of Africa, which at that point consists of a narrow strip of vegetation fringing the Libian Desert. (See map, fig. 1.)

The butterfly flew rapidly past the ship from south to north, or perhaps south-west to north-east, without making

any attempt to reach it; in fact, the general tendency of all seen was to avoid the ship by flying over it or slightly to one side, as butterflies when migrating on land do with similar obstacles.

The wind was very slight from the west or north-west, following the steamer and causing the smoke to hang over it. The sea was almost dead calm, and the sun shining brightly.

At a quarter to ten another butterfly was seen. Between 10 and 11 a.m. five more were observed, all going full speed to the north. Between 11 a.m. and noon nine more passed the ship, or a total of sixteen in the two and a half hours. Between midday and two o'clock no definite watch was kept, but the insects were casually observed to be still passing. Between 2 and 3 p.m. a close watch was kept, and no fewer than twelve more butterflies were recorded, all flying in the same direction.

By 3.30 p.m. we were in sight of Alexandria, but hasty observation showed that the insects were still passing.

An examination of the map (fig. 1) will show that the butterfly seen at 9.30 a.m. had already completed about one-fifth of its 350-mile journey across the Mediterranean, and further that the total width of the observed migration was at least one hundred miles. There is no means of knowing to what extent it was going on on either side of this.

No specimen of the butterfly could be caught, but some were seen from within two or three yards; in one case even the markings on the fore-wings were visible, leaving no doubt that the species was *P. cardui*. Further confirmation, if needed, is found in the fact that this is the only Vanessid which is common in Egypt and is a well-known migrant.

There was, as noted above, very little wind, what there was being fitfully from the west to east, so that the general direction of the flight was across the wind. The map shows the migration in heavy arrows and the wind direction in small arrows, as given in the meteorological map for that day published by the Egyptian Meteorological Service. A fuller discussion of the relation of the flight to wind and barometrical pressure will be found in the second part of this paper.

VII. *Pyrameis cardui* in Palestine in 1922.

Through the kindness of Dr. P. A. Buxton I am able to include the following records, which were given to him or which he observed himself, on the movements of this species in Palestine.

On the 13th March, 1922, *P. cardui* was seen at Hebron flying southward in numbers at 3 p.m. The sun was bright and there was very little wind. Fifty butterflies passed a stationary car in two minutes (A. F. Buxton).

On the 14th March at 8 a.m. they were flying to the north-west at Jerusalem. There was a steady movement. The flight was two to three feet from the ground. It was a bright clear day with a slight wind from the north-west. On the 15th and 16th March, with similar weather conditions, the same movement was seen.

On the 4th April, between 11 a.m. and noon, at Wady Kurn, Anti Lebanon, west of Damascus, at a height of about 500–600 feet, there was a huge migration going north. Dr. Buxton says, "We passed through it for perhaps ten miles, more or less continuously, and through other small droves. At one place there were two hundred or so crossing the road within thirty yards in front of us." The sky was cloudy and the wind was very gusty from the north-west, sometimes violent and blowing athwart the migration.

From the 12th to the 16th March Mr. H. S. Philby was travelling from Ammam in Transjordania to Kaf in Wadi Sirhan, Arabia, and back, and he reported to Dr. Buxton that he saw *P. cardui* migrating out of the desert towards the west the whole time. There was very little wind.

This last record is a very remarkable one, and, as it is difficult to imagine *P. cardui* breeding in any numbers in the middle of the desert, indicates that the butterflies must cross the desert from the Persian Gulf or Mesopotamia. This is an interesting increase in our knowledge of the undoubted annual northward movement of *P. cardui*, and is confirmed by a note in J. W. Tutt's summary of migration (Ent. Record, xii, 1900, p. 151) that in 1879, a year of a huge influx of *P. cardui* into Europe, "a painted lady was seen sunning itself on the bare rocks in the Great Desert of Nefud in Central Arabia at least 400 miles from any place where the larvae could have fed up." Unfortunately Tutt does not give the reference for this information.

It is important to note that the only one of the above flights that is recorded as being towards the south is in the afternoon, while those in the morning are to the north. This fits in with the observations recorded by Poulton on a change in the direction of flight of *P. cardui* in the Sinai Peninsula from morning to afternoon (Proc. Ent. Soc. 1921, p. xii).

VIII. *Pyrameis cardui* in Egypt.

While dealing with the migration of this species it might be as well to record that since my residence in Egypt I have seen no indication of any migration, and I have questioned a number of local naturalists none of whom has ever noticed any definite movement of this butterfly. At the same time I believe that some movement does take place in the spring at least, as in February of this year (1922) it was by far the commonest butterfly near Cairo, whilst by May there was only an occasional specimen to be seen. It remained scarce during the summer, and began to increase again in numbers in September.

On the 14th July, 1922, Mr. T. W. Kirkpatrick saw what may have been a migration along the coast near Alexandria. He records that on this date at Mex, near Alexandria, he saw *P. cardui* flying from east to west along the coast and apparently coming over the harbour from Alexandria. They were not common, only about one every fifteen minutes, but none appeared to stop, and they were obviously struggling against being blown inland by a fairly strong north wind.

On the 15th July more were seen behaving as above, chiefly between eight and ten in the morning, but a few between five and six in the evening. The wind conditions were the same.

On the 18th July, at a spot about twenty-five miles west of Mex, *P. cardui* was fairly common and there was no sign of movement.

IX. *Agrotis upsilon.*

It seems worth while to refer here to the fact that there is a certain amount of evidence accumulating to show that *Agrotis upsilon* may migrate, although no actual movement has been recorded.

The species is cosmopolitan (a frequent characteristic

of migrating species) and in certain parts of the world is a serious pest.

In some of the low-lying lands of the Ganges Valley it appears every winter in enormous numbers after the floods have subsided, and breeds throughout the cold weather, disappearing as soon as the hot weather returns. In the Himalayas, however, about 200 miles away, it breeds throughout the summer. No trace of adults, larvae or pupae can be found during the summer in the low-lying country, which is often under water for some weeks, and it has been suggested that there is a migration every fall from the hills to the valley, and possibly a return to the hills in the spring.

In Egypt something similar occurs, as the insect appears, often quite suddenly, as a pest in Upper Egypt at the beginning of winter, and disappears almost as suddenly the following spring.

Dr. L. H. Gough tells me that on the 21st April, 1915, he found two specimens of this moth sheltering under stones in the daytime in the Western Egyptian desert half-way between Dakhla and Kharga oases, and about forty miles from any cultivation. This is further positive evidence of their migratory habits.

X. *Cydamon* (*Urania*) *leilus* in Trinidad.

In continuance of my notes on this species in Trinidad (see Trans. Ent. Soc. 1920, p. 159) I may say that in the autumn of 1920 there was no definite migration of this insect from Venezuela, and during the year I saw only a few isolated specimens.

Part II.

General Discussion.

It is difficult to find a definition of migration, in the sense in which it is usually understood with regard to insects, that is not open to criticism. If we make it too narrow, we may exclude some important evidence. If we make it too wide we may confuse the issue by including accidental and unwilling movements of the type of Darwin's "floating log."

Poulton (Proc. Ent. Soc. 1912, p. xiii) has objected to

the use of the word "migration" and proposes to call it "emigration," but this appears to be laying undue emphasis on one of three processes—emigration, transmigration, and immigration—that are combined in the complete movement. It has yet to be proved whether the departure or arrival is more fundamental, and indeed the emigration may in some cases be preceded by an immigration or collection of individuals into one locality before starting on their journey.

A definition which seems to cover the ground without committing to any theory, whether mechanistic or teleological, is that migration is the self-contributary movement of insects over greater distances than their normal daily wanderings, usually in numbers but sometimes only a few or even single individuals.

The word "self-contributary" is used to eliminate the passive distribution of insects by strong winds, water currents, railway trains and other agencies.

It should be noted that the enormous flights of Aphids which are occasionally seen blown along by the wind would come under the category of migration, if it could be shown that they took to the wing when they were more particularly liable to be blown by wind. This question will be discussed more fully below when the influence of wind is described.

Although insect-migration is of the same order of phenomena as bird-migration it differs from it in some important points. Chief of these are the complete elimination of the possibility of memory or education influencing the flight, and the almost complete absence of any definite return journeys. In nearly all cases insect-migrations seem to be in one direction only, and when, as in the case of *Danais plexippus* in the United States, there is slight evidence of a movement both ways, each takes place at a different time of the year and with individuals of a different generation.

In studying the causes of migration we must distinguish carefully between the possible advantages (and disadvantages) to the species as a whole to be gained by the movement and the actual immediate internal and external conditions which determine the moment of its occurrence.

While it may be true that an insect by migration at a particular time will reach better conditions of food or climate, such an explanation leaves us in the dark as to

the factors which cause the individual insect to migrate at that particular moment in that particular direction.

There is little doubt that in the long run the teleological explanation of advantage and disadvantage will account for the survival of migrations, or migratory species, but the blind influence of forced movements, which demand explanation, is strongly indicated by the cases of large flocks of butterflies flying straight out to sea, or by the almost annual spread of *Pyrameis cardui* into large areas of Europe where it cannot survive the winter, and from where we have no evidence of any return.

Dealing, then, with the immediate internal and external factors which may possibly influence the migration, they can be conveniently divided into those determining the start, the direction, the duration and finish of the flight.

They are indicated in the following table.

	External.	*Internal.*
Start.	Overcrowding.	Hunger.
	Shortage of food.	Sex impulse.
	Moisture (shortage or surplus).	Periodicity or habit.
	Temperature.	Imitation.
	Electrical state of atmosphere.	
	Wind.	
	Light (sun and moon).	
Course.	Wind.	Instinct (? habit).
	Sun and (?) moon.	Imitation.
	Pressure.	
	Temperature gradient.	
	Moisture gradient.	
	Contour of land.	
Finish.	Arrival at required conditions,	Fatigue.
	or	End of reserve energy supply.
	Failure of previous stimulus.	Development of sex organs or other physiological state.

It must of course be recognised that in all cases both external stimulus and internal response will be necessary, as every insect does not migrate, in spite of the most favourable circumstances, and even the best-known migrants require certain conditions before they will move.

We will now discuss the various stimuli and their relation to known flights.

Wind.

It has been suggested above that the big flights of Aphids and other insects drifting with the wind could be classed as migrations if it could be shown that they took

to wing on the advent of such conditions as would lead to their being so distributed.

There seems to be no definite evidence with regard to Aphids on this point, but C. L. Corkins (Canadian Entomologist, 1922, p. 1) states that *Melanoplus atlantis*, a grasshopper, always migrates with the wind, and that when resting on the ground they will deliberately rise in the air when the grass is disturbed by strong winds. This appears to be a definite case of the wind influencing the start of a flight.

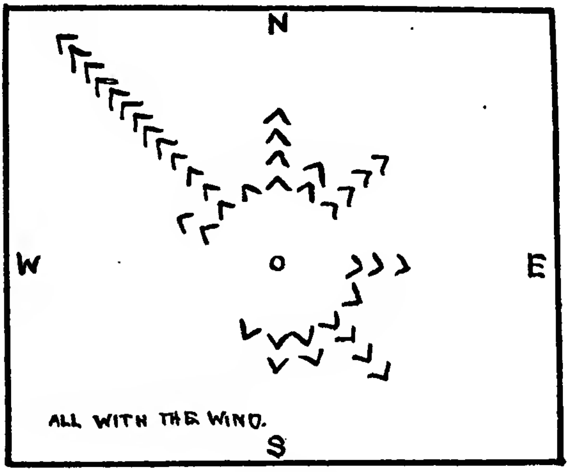

FIG. 2.

A more complex case is that described by Hudson ("Naturalist in Le Plata," Ch. ix), who reports that large swarms of a dragon-fly, *Aeschna bonariensis*, appear five to fifteen minutes before a violent wind locally known as the "pampero," flying at a great speed in the same direction as the coming wind, which is towards the north-west.

The influence of the wind on the direction of flight is probably of great importance. The dragon-fly mentioned above always flies in the same direction as the wind, but as the wind is always in the same direction the association might be accidental.

The grasshopper *Melanoplus atlantis* is a more instructive case of flight with the wind, as Corkins (*loc. cit.*) has recorded flight in almost all directions and yet invariably with the wind. Fig. 2 shows the directions of flights

recorded from 9th July to 12th August, 1920, in North Dakota, all with the wind.

Other insects appear to fly most frequently across the wind. Fig. 3 gives the records to date for *Catopsilia statira* and *eubule* in British Guiana taken from the papers of L. D. Cleare (Trans. Ent. Soc. 1921) and myself (Trans. Ent. Soc. 1917), and shows that the twenty-one recorded flights are all diagonally across the almost constantly prevailing north-east Trade wind.

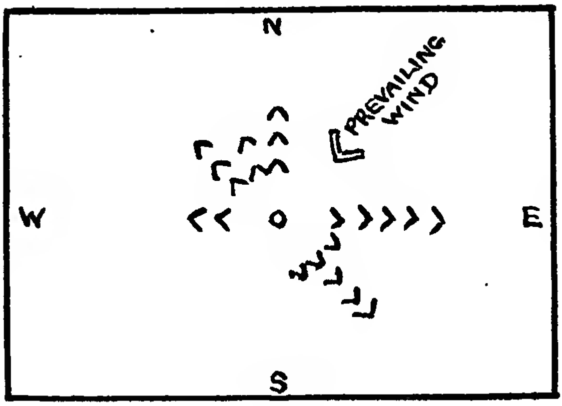

Fig. 3.

It might be as well to note here that once an insect is in the air it is not more difficult for it to fly with or against or across the wind, provided that the wind remains constant. Its speed relative to the ground will alter according to its direction, but its speed through the air will be the same. From a drifting balloon it is impossible to give the direction of the wind without observing an object on the earth, and from an aeroplane which is moving relative to the air the same holds good.

At the same time in a gusty wind it should be possible for a slow-flying insect to have some idea of direction as, owing to it possessing a slight momentum, sudden changes in wind speed would be momentarily perceptible before they had affected the whole insect. On this reasoning it should be possible to distinguish between a head wind and a side wind, but a sudden drop in a head wind ought

to produce the same sensation as a sudden increase in a wind from behind.

The whole question of the mechanics of insect-orientation relative to wind has not yet been properly studied.

Migration directly into the wind does not seem to be quite so commonly recorded as migration across the wind, but it would be easy to mention many cases to show that it occurs. On p. 212 of the present paper *P. cardui* is recorded as flying directly against a north-west wind in Palestine on 14th, 15th, and 16th March.

The strength of the wind will, of course, influence the direction of the flight.

N. A. Comissopolis in an unpublished note in the files of the Physical Service, Ministry of Public Works, Egypt, says: "It is known that locusts fly against the wind with a certain inclination, which is in all probability to the left. With the increase of the wind this angle becomes greater and greater, so that with a strong wind the locusts fly at right angles to the wind. When the wind increases more and more, say over 50 km. an hour, this angle of flight becomes obtuse, and so finally the locusts are driven back by the wind."

Dealing with the same locusts Dr. L. H. Gough (Report on the Great Invasion of Locusts in Egypt in 1915, Govt. Press, Cairo, 1916, p. 21) says: "In a gentle breeze they fly directly up the wind, if it strengthens they immediately respond by changing their direction to the wind. In a moderately strong wind they will be observed flying at right angles to the wind direction, and as the wind velocity increases their line of flight is turned more and more, until we find them flying down the wind when a gale is blowing."

This is a confirmation of the previous note, but Gough makes the interesting suggestion that, instead of flying always with one flank to the wind, they may turn always one flank to a rising wind and the other to a falling wind. He was unable to test this by observation, but it should be kept in mind when dealing with any future migration.

The relation between strength of the wind and direction of flight will probably hold good over a limited range, but as wind is not the only determining factor most insects would cease to migrate before the strength of the wind was sufficient to reverse their direction.

One of the most interesting aspects of the relation of the direction of wind to the direction of flight is found in those

cases in which the direction of flight reverses during the day, and Prof. Poulton (Trans. Ent. Soc. 1922, p. xii) has brought strong evidence that this reversal is in some cases correlated with a regular change in the wind direction, for instance the land and sea breezes on the coast. The recorded cases of these reversals are few, and in most of them nothing definite is known about the wind directions. Prof. Poulton's records are from Malay States for *Delias* spp. and *Dysphania* spp., and the Sinai Peninsula for *P. cardui*.

In the present paper *Catopsilia statira* is recorded by Hall as reversing in direction in Costa Rica in a locality which is near enough to the coast to be under the influence of the sea. But Goeldi (Boll Museo Goeldi (Para Brazil), iv, 1904, p. 313) records that *Catopsilia statira* on the rivers in Brazil flew from north to south in the morning and from south to north in the evening. No mention is made of the wind direction, but if a change in this occurred it is not the normal land and sea change that occurs on the coast.

Attention has been drawn in this paper (p. 212) to the fact that the only record of *P. cardui* flying south in Jerusalem was also the only record for the afternoon.

A complete understanding of this problem can only be obtained by further and more critical records, but it must be recollected that the wind is not the only factor which changes direction during the day. In fact, while a regular daily change of wind direction is a local phenomenon, the daily change in the direction of the sun's rays is universal. We will now consider to what extent this may be also concerned.

Influence of Light.

I have pointed out in my record of *Catopsilia statira* in Trinidad (Trans. Ent. Soc. 1919, p. 86), and also in British Guiana (Trans. Ent. Soc. 1917, p. 158) that the flight was always thickest in bright sunlight, and fell away immediately a cloud passed over the sun. The sun apparently influences the activity of the flight. Has it any influence on the orientation?

The orientation of insects at rest in relation to the sun's rays has been known and studied for many years. Some butterflies face the sun with their wings closed; others rest at right angles to the sun's rays and may lean towards

or away from the sun with their wings closed, producing maximum or minimum illumination of the underside of their wings and maximum and minimum shadow. Others, again, turn their face away from the sun, and, with wings expanded, assume a position as near as possible at right angles to the sun's rays.

Dragon-flies and many other insects also orientate when at rest, and many speculations have been made on the value of such habits to the insect. The question has been attacked from the mechanistic point of view by Loeb, who shows that most of the attitudes can be explained on the theory that the positions are "forced movements" caused by the unequal light stimulus on the two eyes producing different muscular contractions in the two sides of the body. ("Forced Movements, Tropisms and Animal Conduct," Philadelphia, 1918.)

The insect usually takes up a position in which both eyes are equally illuminated, in which case the muscular contractions on both sides of the body are similar and the attitude is symmetrical. If, however, the illumination is from one side only, the optic nerves will be unequally stimulated, causing an unsymmetrical contraction of the muscles, with the result that the insect leans to one side or the other.

Loeb extends his theory to the case of a moth flying to a light, and shows that this occurs because only in flying straight towards the light are the two eyes equally illuminated. If the insect deviates from this line the eyes become unequally illuminated, the muscles of the two wings are unequally stimulated, and the result (in a positively heliotropic insect) is to return once more to the light.

The complete absence of like and dislike from the problem is shown by the fact that if one eye of the insect is covered with an opaque material it no longer flies to the light, but round it with the darkened eye towards it.

Dr. George Bohn in the Bull. Inst. Gen. Psychologique, 1906, and in the Bull. Soc. Ent. France, 1907, pp. 25–36, discusses the relation of the flight of butterflies to the direction of the sun's rays. He comes to the conclusion that flight is strongest when away from the sun in those insects which tend to face away from the sun when at rest. The wind, however, has more influence, and the insect tends to fly into the wind and away from the sun.

Although Bohn was dealing with ordinary flight and not

with migration, it is possible that we have here a key to some of the puzzles of the direction of flights. It will be seen that in Poulton's map of the migration of *P. cardui* in Sinai (Proc. Ent. Soc. 1921, p. xvii) the morning flight is slightly west of north and the evening flight slightly east of south, both of which are diagonally away from the sun. In this case we have evidence that leaves little doubt that the wind is the most important factor. At the same time the sun may be having a small effect, and it would be interesting to see if there is any slight change in flight direction of *P. cardui* in localities where the wind remains constant as the sun moves from east to west.

Goeldi's record of the change of direction in the flight of *Catopsilia statira* in the interior of Brazil (*loc. cit.*) and Hall's record for Costa Rica given above may possibly be cases of sun influence, but the whole question requires reinvestigation from this point of view before too many conclusions are drawn.

My own record of the change in direction of the flight of *Calpodes ethlius* in Panama (Trans. Ent. Soc. 1920, p. 155) is difficult to fit into any theory, as the insects did not start to fly till the late afternoon, and invariably chose a hazy day when the direction of the sun's rays was indefinite and when there was practically no wind.

It should be noted in this connection that in the tropics the sun is almost overhead at midday, and that insects frequently only migrate in the morning and evening.

If the sun has an influence on the orientation of insects by day, it is possible that the moon has a similar effect by night, but our knowledge of the migration of night-flying insects is so small as to make discussion useless.

Barometric Pressure.

In 1915 there was a big invasion of migratory locusts (*Acridium peregrinum*) into Egypt. These were first reported on the 2nd February, and came in a series of waves throughout February, March, April, May and June. In these months there were eighteen definite invasions. Dr. L. H. Gough (Report on the Great Invasion of Locusts in Egypt in 1915, Govt. Press, Cairo, 1916, pp. 18–20) has pointed out the remarkable fact that every one of these invasions corresponded to the approach of a barometric depression either into the Nile Valley or near enough to

affect the weather there. Further, "seventeen successive depressions were each attended by a fresh influx of insects."

In an appendix to the same report (pp. 69–70), dealing with the occurrence of the locusts from August to December, six more invasions are mentioned, and again the dates of these correspond to the approach of depressions.

Dr. Gough sums up: "Depressions evidently favour the commencement of migration of locusts into Egypt, but it is certain that not every depression brings locusts, and probably not every locust invasion need be stimulated by a depression."

These observations are of great interest, and at once raise the important question as to how the effect is brought about. It is difficult to imagine that the insect is conscious of the change of barometric pressure as it flies, and if we eliminate this it must in some way be bound up with the distribution of wind or temperature round the cyclonic system.

In a cyclonic system winds are blowing spirally towards a centre of low pressure in gradually increasing strength as the centre is approached. A locust with wind responses as described above would be blown by the wind towards the centre once it reached the position at which the wind was strong enough to cause it to fly with it. On the other hand, there should be a tendency for the insects on the outer edge of the cyclone to fly against the lighter wind away from the centre.

If there is anything in the suggestion that one flank is usually turned towards the wind we should expect to find differences of behaviour in the northern and southern hemispheres, as the direction of rotation round the centre of depression is different. So far as I am aware nothing of this kind has ever been looked for or observed.

In fig. 1 of the present paper I have put in the isobars for the day in which the flight of *P. cardui* was observed. It will be seen that the flight is more towards than away from the centre of the depression, but not very definite.

I have also examined the pressure distribution in the Eastern Mediterranean during March 1922, when the flights of the same insect in Palestine took place, as recorded above. The feature of the month was a prolonged anticyclone of very high pressure from the 9th to the 24th March. Thus the butterflies flying westward in Palestine were going into an area of high pressure. On the other

hand, on the 4th April, when Buxton observed a huge migration going north near Damascus, there was an area of low pressure over the north of Palestine.

It is not intended to draw any conclusions from the above remarks—they are obviously too few and too fragmentary. Every insect has its own responses and must be studied separately. At the same time they may serve to show the shortcomings of the present observations and the type of evidence that is required.

Influence of Temperature.

It is probable that all insects have temperatures of maximum activity, and if the daily range of temperature in the locality where they live is great, then their movements, including migration, will be controlled by it.

Thus Uvarov has pointed out (Bull. Ent. Res. xii, 1921, p. 135) that young locusts in South Russia migrate at certain times of the day and feed at others, apparently dependent on temperature.

This question is a simple one. Much more difficult to consider is whether certain temperatures definitely excite the migratory instinct, and whether the route taken is in any way related to temperature changes or temperature gradient. In other words, does a migration take place from a less suitable temperature to a more suitable one?

If a number of insects are confined in a long glass tube the temperature of which is constant but falls steadily from one end to the other, most of the insects of any one species will take up a position in the tube corresponding to some definite "optimum" or at least "most pleasing" temperature. For example, with house flies this is about 29° C. (84° F.). If at the hotter or colder end of the tube they move towards the part at this temperature.

We are here dealing with a temperature gradient over a distance of a few feet. Natural gradients, however, usually extend over many miles, as indicated by isotherm lines in meteorological charts, and the change in temperature over even a mile or two is almost imperceptible. Is there any reason to connect the migration of insects with these gradients? Up to the present no study has been made on these lines, so that it is impossible to answer the question. At the same time it should be pointed out that there is evidence of a general drift northwards of

P. cardui from North Africa and Asia Minor into the cooler parts of Europe each summer. In Egypt it is commonest in the winter and in England in the summer. It might be that it is following an optimum temperature. Unfortunately there is no southward movement on the advent of cold weather, and all the most northerly wanderers are killed off during the winter.

Danais plexippus in the United States, on the other hand, has a very definite southward migration in the autumn, but there is no conclusive evidence of a northward movement in the spring. Is it in the autumn seeking a warmer temperature to continue breeding? and, if so, whence come the parents of the new generations in the north in the following year?

If there is any question of temperature connected with the above movements, is the effect direct or indirect? In view of the almost imperceptible change of temperature over even considerable distances it appears more likely to be indirect. If the district is above the surrounding temperature the air will tend to rise, and as a result cooler winds will blow in from the surrounding districts. By orientating against such a wind cooler districts would be reached.

So far as I am aware it has never been suggested that insects might orientate into wind at one temperature and away from wind at another. It is known that other tropism can be changed according to temperature. This possibility should be kept in mind when observing future migrations.

The question of the value or dangers—the teleological view—of this movement will be dealt with later.

Influence of Moisture.

Many of the remarks made above with regard to temperature apply also to moisture. Most insects have an optimum moisture. The moisture gradients are, however, so slight in nature that it is difficult to imagine that any influence can be direct. But there are wet winds and dry winds, and perhaps insects respond differently to each.

I have pointed out that in Trinidad and British Guiana most of the records of migration of *Callidryas* spp. are in the wet season. There are, however, exceptions. Other insects are supposed to move at the change of the season

from wet to dry or vice versa. As before, much more complete data are required before it is safe to draw conclusions.

Coast Line and Contour.

Danais plexippus in the United States and other insects in other parts of the world have been recorded as following the coast-line in their migrations. Over small inlets or mouths of rivers they will cross the water, but in larger bays they follow the windings of the shore.

In British Guiana, as I have already pointed out, the two main directions of flight are parallel with the coast.

On the other hand, the flocks of butterflies occasionally seen flying straight to sea show that this is no invariable rule.

According to Weissenborn, dragon-flies in Germany when migrating followed the courses of the rivers (Loudon's Mag. Nat. Hist., 2nd Series, III, 1839, p. 516).

In the big migration of *Catopsilia statira* in Trinidad in 1918 (Williams, Trans. Ent. Soc. 1919) there was a large movement along the foot of the northern range of mountains, and a few occasionally seen flying up or down the valleys between the spur hills, but no general migration over the mountainous country.

Observations such as these, which could easily be multiplied, show that the contour of the country may have a definite effect on the course of migration of certain insects. It seems probable that in the case of coast and river this is effected through sight, but so little is known as to the distance at which insects can see objects that it is dangerous to jump to conclusions.

Electrical State of the Atmosphere.

In reading through a number of records of insect migration one is struck by the many cases in which thundery weather follows the passing of the insect. It is also well known to collectors that insects in general are more active on hot oppressive evenings before a thunderstorm.

I know of no method of recording this condition of the atmosphere, or even if it is a real phenomenon or only a particular combination of temperature and humidity. If it is real, then it requires to be studied in relation to insect activity and migration.

Food Supply and Overcrowding.

It is frequently stated that insects migrate because of a shortage of food in the locality from which they start. This food may be for themselves or for their offspring. In the first case it is the instinct of hunger, and in the second the sex instinct that is concerned.

Overcrowding may be a cause of food shortage, but it is doubtful if it is a primary cause of migration, as one of the usual preliminaries of migration is a congregation of individuals which would otherwise be more widely scattered.

If the hunger is due to a change of season affecting the food or water supply, we have a number of other factors involved, such as temperature, moisture and wind, which would be difficult to eliminate from the cause of any movement.

Hunger might be a cause of the liberation of the migratory instinct, but it could not determine the direction or the route of the flight.

INTERNAL STIMULI.

The internal stimuli which may come into play in determining migration are of two kinds, irregular and periodic.

The irregular stimuli include hunger and the habit of imitation. The regular periodic stimuli are the sex impulse, occurring in the life of each individual, and perhaps also certain impulses due to a regular change in external conditions (*e. g.* seasonal) which have become rhythmically instinctive and no longer dependent on the external change.

Hunger.

This internal stimulus is so directly dependent on the external condition of food shortage that it has been discussed above under that heading.

Imitation.

Certain insects, particularly species of the genus *Catopsilia* and also *P. cardui*, have a habit of flying in short strings of four or five individuals in a "follow-my-leader" fashion. If one butterfly flies past another will leave its occupation and fly after it.

There is little doubt that this habit of imitation is occasionally a factor in migration. It will not apply to a very thin migration where the individual insects are out of sight of each other, but I have shown that, in Trinidad, if two or three butterflies in a thick migration were disturbed, others with which they came in contact were also put off their direction and flew round aimlessly until they were gradually put on the track again by the main flight.

I imagine that this habit of imitation also accounts for the usual small admixture of other species in a big flight chiefly of one kind. The migration of *C. statira* in Costa Rica described above is an example of this, showing that occasional specimens of *C. argante*, etc., had been unable to resist the impulse to join in.

The Sex Impulse.

That the sex instinct is sometimes bound up with migration it is impossible to deny. Otherwise one cannot understand the migrations which consist only of one sex, usually male, but occasionally only female.

It is generally assumed that insects migrate before egg-laying. This is most certainly true of the migratory locusts, as in these the sexual organs do not fully develop until after the migratory flight is finished.

According to Shannon (Harper's Magazine, cxxxi, 1905, p. 617) Eimar records dragon-flies flying south in Sils Maria with ovaries full of ripe eggs. But in the majority of cases nothing is recorded as to the sexual condition of the migrants, and it is assumed rather than proved that they have not yet laid.

The reason why in some species the flights consist only of males is still a mystery. One might be tempted to think that the females migrated at another time were it not for the record of a huge migration of *Hibernia aurantiaria* and *defoliaria* observed by Gaetke at Heligoland in 1872. In this case no proof is needed that only one sex migrated, as the females of these species are wingless and cannot leave the ground.

The maternal instinct which causes the parent to seek suitable food for her offspring has been mentioned above in connection with food shortage.

The method—chemotropic or otherwise—by which an insect recognises the food which its offspring requires is

difficult to comprehend. Still more so is the possibility that it might travel for long distances into a country that it had never seen, to find food that it will not eat, for offspring that it will never see.

Rhythm.

Once more we are faced with a subject about which little or no accurate knowledge is available.

There is little doubt that in the lives of certain animals rhythms are set up by the regular occurrence of day and night, winter and summer, high and low tide, and other changes in the environment. These rhythms may become so engrained in the nature of the animal as to persist at least for a time if the external stimuli are removed or even reversed.

Thus certain plants when brought from one hemisphere to another keep for some time the old rhythm and flower or fruit at the wrong season.

It is therefore possible, and so must be remembered, that if certain external conditions, which caused an insect to migrate, occurred sufficiently regularly, sufficiently frequently and over a sufficiently long period to set up such a rhythm, the migration might take place in an exceptional case when the stimuli failed to appear at their normal time.

Such a rhythm, if based on a seasonal change, might occur every generation, or in a quicker breeding insect, every second or third generation, and might even be found in the case of a widely distributed species in localities where the necessary stimulus never occurs.

Advantages and Disadvantages.

Leaving the mechanistic side of the problem of migration we must consider the teleological aspect, the value of such a movement to the insect.

There is no doubt that the migratory habit cannot be, on the average, an actual disadvantage to a species possessing it, for in such a case it would lead to the extinction of the species unless correlated with some more advantageous character.

If an insect is capable of living under varied conditions migration will cause it to be widely distributed. A glance

at the world-wide distribution of *P. cardui* and *Danais plexippus* shows the possibilities in this direction.

On the other hand, some writers go to the extreme of thinking that every movement must be an advantage, if not to the individual, at least to the species. The cases recorded of thousands of butterflies flying out to sea should dispel the idea that it always benefits the individual.

The failure of a regular migration to benefit the species seems to be illustrated by the puzzling case of the northward spread of *P. cardui* each year in Europe, which has already been alluded to. There is little doubt that an enormous number of individuals fly so far north that their offspring are unable to survive the winter, for *P. cardui* cannot hibernate as do the related *Vanessa io* and *V. urticae.* Yet there is no evidence of any return flight, so that all these migrants are completely lost owing to their instinct failing to discriminate between "far enough" and "too far."

It is also difficult to find a value for the migration of enormous numbers of males of a species, when the females have stayed behind. There can be no question of avoiding overcrowding or of spreading the species into new localities. The case of *Hibernia aurantiaria* has already been alluded to, in which all the females are wingless.

A necessity for intercrossing to prevent too close inbreeding might be suggested as a possible cause of this type of migration, but even if the value of the result is admitted, it is difficult to suggest why the effort takes the form of sudden migrations of large numbers of individuals in the same direction.

Data required.

Having reviewed the factors that are possibly concerned in migration, and having criticised the shortcomings of most of the evidence, we must point out the type of information that should be expected in future in an ideal case. The observations should include the following:—

The locality of observation.

The date or dates.

The species concerned. If more than one, their relative frequency.

The condition of the specimens.

The approximate numbers of insects passing in a given time and in the whole flight.

The proportion of the sexes concerned.
The sexual development of the individuals.
The direction of flight.
The height and thickness of the flight.
The speed of flight.
The width of the flight.
The time of the start and finish of the flight or flights.
The condition of the sky.
The relation of the date to normal changes of season.
The direction, force and constancy of the wind, and whether normal or abnormal.
The temperature at the start and finish, whether normal or abnormal.
The electrical state of the atmosphere before and during flight.
Recent rainfall and humidity, whether normal or abnormal.
Any differences in direction of flight at different times at the same place, with particular reference to regular diurnal changes or reversal.
Any difference in direction of flight at the same time in different places, *i. e.* fan-shape spread or change in direction of route.
A meteorological map of the district showing isobars, isotherms, wind and rain for the area of the flight during its occurrence and for the preceding few days.
Any tendency of the insects to follow coast-line, roads or contours.
Whether similar flights are known in the district, if rare or common, and if always the same species, direction and time of year.

In case the migration can be traced over any considerable part of its course as much as possible of the following addition information should be given.

The locality of the start, its nature and vegetation.
The date and time of start.
The climatic conditions previous to the start.
The route considered in relation to contour and to vegetation.
The duration of the daily flight or flights.
The type of country and vegetation at the finish.

A few cases fully described with most of the above particulars would carry us farther towards solving the problems than many hundreds of incomplete accounts, and it is hoped that fortunate observers will soon bring forward some evidence. At the same time there is still room for every note, however fragmentary, which should be recorded in a recognised entomological journal, not in a newspaper or other transient publication.

Final Conclusions.

It is some consolation to find that after many years' close co-operation and many hundreds of thousands of observations and experiments, students of bird-migration are still without a certain explanation of their phenomena. It is then easier to admit that in the study of insect-migration, with a few hundred fragmentary records, we are far from any solution of the numerous problems.

Some innate tendency to migrate must be present in the species, but this will require a suitable concurrence of external conditions in order to develop.

The question of the determination of direction still remains unsettled. An external factor, such as wind, cannot be said to be the real determining cause unless—other things being equal—migration takes place in all directions in the same proportions as the frequency of the prevailing winds and in the same relation to them.

If an insect always migrates in one direction in a locality where the winds are constant it is difficult to prove the connection. If the winds are constant and the flight variable, or if the winds are variable and the flight constant, then the wind is not the chief factor. If both flight and wind are variable, then a connection between the two must be sought.

It is difficult to avoid considering that, in addition to the instinct to migrate, many species have also a tendency to go in a certain direction, although it is impossible to say by what means they know it.

If this direction-tendency is strong they will migrate in that direction independently of external conditions. If it is weaker they will only migrate on those days on which the external conditions facilitate movement in that direction. If it is absent the direction will be entirely determined by external stimuli.

The only alternative that I can find to this suggestion of innate directional power is that mentioned above, that the tropisms of the insect must change according to temperature or perhaps moisture, so that an insect would fly into a wind of one temperature and away from one of another. In this way an insect which flew into the warm winds and away from cooler ones would (in the northern hemisphere) gradually move south in spite of the changes of the wind.

Between these two suggestions, and any others that can be put forward, future investigators must decide.

Cairo, October, 1922.

IX. *The Classification of the Family* Carabidae. By THOMAS G. SLOANE.

[Read May 2nd, 1923.]

AN arrangement of the Carabidae is put forward here in which the variation in form of the anterior cotyloid cavities is given a higher taxonomic value than has hitherto been the case. The old systems of classifying the Carabidae culminated in 1853 in the publication of Lacordaire's great work on the "Genera des Coléoptères"; in that year Schiödte inaugurated the new system which was briefly elaborated by Schaum in his paper, "Das System der Carabicinen" (1860). Schaum's work formed the foundation for G. H. Horn's very meritorious monograph "On the genera of Carabidae with special reference to the fauna of Boreal America" (1881). The influence of H. W. Bates on modern opinion was considerable, and others, including L. Ganglbauer, T. Tschitscherine, and E. Bedel, have suggested a good many alterations and modifications of Horn's views.

An important matter is the use of the right names for the tribes under the law of priority. I regard any name for a group of higher rank than a genus, which has been published, as the equivalent of a tribal name; and, therefore, believe that the names used by Bonelli for his stirpes, which were founded on genera, are to be taken as corresponding to the tribal names now employed. It seems to me that the validity of the names Pterostichini and Trechini depends on the recognition of Bonelli's stirps-names.

Below are given some notes on the taxonomic value of several parts of the body.

Setosity.—No attempt is made here to appraise the taxonomic worth of the innumerable differences in the development of setae and pubescence which are to be found in the Carabidae. The whole subject requires more attention than it has received. Good use can be made of setae and pubescence, especially for helping to define groups of genera in large tribes, and groups of species in large genera. Every external part of the body may bear setae in some species; I have seen a fringe of hair along the inner edge of the inflexed lateral margins of the elytra

only in the genus *Dioctes*. Parts on which setae are rarely found are the mandibles, lobes of mentum, inflexed margins of prothorax and elytra, inner edges of anterior and middle cotyloid cavities. The males are remarkably villose on the under surface in some species of the genus *Catascopus*. In many species of the tribes Graphopterini and Anthiini the pubescence forms an ornamental pattern; this occurs nowhere else in the Carabidae.

Fixed setae.—These are strong setae, or bristles, which occur at definite positions on various parts of the body. Their value in taxonomy is recognised, and usually they have been called tactile, or sensitive setae, but the term fixed setae, proposed for them in 1915 by Dr. Walther Horn, seems the best; for, although some of them may be tactile, or sensitive, we have no direct evidence that all are so. Another term for the fixed setae is macrochaetae. The supra-orbital setae of the head should not be given so high a taxonomic value as was placed upon them by G. H. Horn, but they are a very useful character. I do not know of a single case in the great tribe Harpalini where there is more than one supra-orbital seta on each side of the head, and in the equally important tribe Pterostichini it is very rarely that there are any variations from the normal number for the tribe, viz. two on each side. In the Carenides the number of supra-orbital setae is hardly more than a specific character, and in the Helluonini there are many Australian genera with one seta, though in all extra-Australian genera there are two.

Head.—A small supra-orbital nodule is found on each side of the head in several genera of the Scaritini (*e.g.*, *Passalidius*, *Coptolobus*, *Cryptoscaphus*, *Haplotrachelus*, *Storthodontus* and *Saprostes*. Cornute processes also occur as a secondary male character in the Scaritini (*Carenidium* and *Oxylobus* sometimes with one mandible and one side of the clypeus more or less cornute), Siagonini (mandibles sometimes cornute), and Harpalini (*Carterus* with mandibles sometimes cornute).

Antennae.—Generally the antennae are more or less setaceous, sometimes they are moniliform. The African genus *Stereostoma* has the widest antennae known to me in the family. Its antennae are short; joints 4–10 stout, but depressed and nearly twice as broad as long. Usually the basal joints to the number of two, three, or four are glabrous, but the antennae may be setose on all the joints.

The number of glabrous basal joints is a useful character; the tribes Harpalini, Bembidiini, and Trechini have invariably two joints glabrous, but in some other tribes the number is not so constant. The basal joint has normally a conspicuous fixed seta on the upper side towards the apex; this seta is absent in the subtribes Scaritides and Carenides, and in the genus *Morio*. Attention may be directed to the position of the antennae in the tribes Graphopterini and Anthiini, where they are inserted so much below the ridge which defines the front before the eyes, that they are on a level with the lower edge of the eyes, a character seen nowhere else in the Carabidae.

Mandibles.—The mandibles very rarely have the basal angles of the upper side concealed by the clypeus, this I only know to occur in the tribes Migadopini and Scaritini. The outer side is usually concave in a longitudinal groove, or scrobe; towards the distal end of this scrobe there is sometimes a fixed seta; the presence of this seta is a larval character, which, though of high taxonomic importance, has not quite so much value as a means of separating tribes as was attributed to it by G. H. Horn; it may or may not occur in different genera of the tribes Migadopini, Pterostichini and Broscini, but, as far as I have observed, its presence or absence is constant in the other tribes of the family.

Labrum.—Normally the labrum is not wider than the clypeus; but in the Carabini (where it is soldered to the clypeus) it is so at the apex; and in the Dryptini it juts out on each side beyond the clypeus.

Mentum.—The mentum varies considerably; it always seems to have a sinus in the middle of the apex except in *Brachylobus* (Chlaeniini). Attention may be drawn to the orbiculate mentum of *Drypta* with its unusually narrow connection with the submentum. The submentum is sometimes armed with prominent processes in the male; the cases known to me where this occurs are *Dioctes* and *Phorticosomus gularis* (Harpalini), and some species of *Gigadema* (Helluonini).

Labium.—G. H. Horn said of the labium, "in every dissection I have made three parts have been present"; he did not discuss the forms of these three parts, but referred the student to the 146 figures of the labium which he published. I am sure that in some cases Horn misinterpreted the form of the labium, *e.g.* in *Enceladus*,

where the paraglossae are actually reduced to mere basal attachments of the ligula, which is wide at the base, and not as shown in Horn's figure. Horn's view as to the taxonomic worth of the labium is contained in the two quotations which follow: (1) "From my own observations I think the labium the most unsafe and unsatisfactory organ that can be made use of in classification." (2) "While I do not believe the ligula to possess the value assigned by some authors, it may be made useful." Horn had given probably more study to the comparative differences in the form of the labium throughout the Carabidae than any other author, so that his views are entitled to great respect. The many variations in the shape of the labium (both ligula and paraglossae) which occur in the tribes Scaritini, Harpalini and Helluonini indicate that this organ has not tribal value in the large tribes, though in the Scaritini the three forms illustrated by Horn's figures 19, 20, and 22 have subtribal importance.

Palpi.—Both the labial and maxillary palpi have been given a higher standing in classification than can be justified. Genera belonging to such widely separated tribes as the Hiletini, Broscini, Pterostichini, Chlaeniini, and Lebiini have in the male the apical joint securiform, in the female not unusually wide, though truncate at the apex; this difference is a very conspicuous one, yet it is only a secondary sexual character. In the comparatively small and compact group of the Carenides (tribe Scaritini) the apical joint of both palpi may be filiform (*Scaraphites*), or cultriform (*Carenidium*); here it is not a sexual character. These cases suggest caution in using the form of the apical joint of the palpi in classification, though its value is sometimes undoubted (*e.g.* in the Bembidiini). The number of setae on the inner side of the penultimate joint of the labial palpi may vary within the limits of a tribe (*e.g.* in the tribe Harpalini, where it is a most useful group-character). The abnormal maxillary palpi of *Amorphomerus* and *Helluodes* are referred to below.

Elytra.—The elytra furnish many characters of taxonomic importance, which vary from those of tribal value, *e.g.* the lateral processes in the Ozaenini and the exceptionally long scutellar striole in the Migadopini, through every gradation to merely specific distinctions. The interstices of the elytra seem to represent the main longitudinal veins, and the striae the spaces between these veins, of the upper

wings of the insect-group from which the Coleoptera are derived; this view gives a reason for the taxonomic value of some features of the elytra, *e.g.* the fixed setae (macrochaetae of the interstices).

Underwings.—It has been thought that the venation of the underwings offers a character of great significance in the classification of the Carabidae, but my investigations have convinced me that the use of the venation in classifying the Carabidae is unlikely to lead to successful results. This is owing to the fact that so many genera, or minor groups, have the underwings varying from those that are fully developed (*i. e.* folded twice towards the tip), to those that are mere rudiments. Only fully developed wings can be used satisfactorily for comparison with one another.

Abdomen.—Horn attributed too high a taxonomic position to the separation of the posterior coxae by a small forward projection of the first ventral segment, though he saw that it lost its value in the Brachynini. He used this feature as one of importance to separate the Promecognathini and Enceladini from the Scaritini. In the Scaritini he said the coxae were contiguous, but the American genus *Ardistomis* and the Australian group Carenides have the posterior coxae separated. In the genera *Catadromus* and *Oribazus* the apical ventral segment interlocks with the elytra at the ante-apical sinuosities by an upturned process. A transverse sulcus beside the anterior margin of ventral segments 4–6 is an important character, but of less than tribal value.

Coxal cavities.—The modifications of the parts of the prosternum and mesosternum which enter into the formation of the anterior and middle coxal cavities are now the leading features in the classification of the Carabidae. The first use of the cotyloid cavities, that I know of, was by Leconte in 1853, when he indicated three forms of the anterior cavities, viz. "open" for those of the true Carabides, "closed" for those of the Elaphrides, and "entire" for those of *Omophron*. In 1881 Horn only recognised two forms—open and closed. In 1853 Schiödte saw the importance of the two forms of the middle cavities. In 1917 I regarded six forms of the anterior cavities as worthy of recognition. These were the following:—(1) The wholly closed form, in which the cavities are closed by a basal declivity which separates the coxae from one another behind. (2) The partially closed form, found

only in *Omophron*, in which there is no basal declivity separating the coxae behind, the coxae being closed by a narrow union of the episternum with the base of the prosternum on each side. (3) The open form, in which the cavities are open and the coxae contiguous behind. (4) The uniperforate type of the wholly closed form, in which the cavity has only a single opening inwards and the epimerum unites with the basal process on each side. (5) The biperforate type of the wholly closed form, in which there are two openings inwards caused by the development of a chitinous bar across the cavity from each side of the antefurca to the epimerum. The anterior opening is that through which the muscles and nerves of the leg pass into the prothorax; the posterior one has no apparent functional use. (6) The false uniperforate modification of the biperforate type, which occurs only in the genus *Silphomorpha*. The allied genus *Adelotopus* has the true biperforate form of the cavity. In *Silphomorpha* the posterior foramen of the biperforate form has been lost and the point of the epimerum has moved forward and become attached to the crossbar of the cavity, the result being a single opening inwards which is the homologue of the anterior foramen of the biperforate form, and not of the single opening of the uniperforate form. The families Hygrobiidae and Hydrophilidae have the anterior coxal cavities resembling those of *Silphomorpha*. All the Carabidae with the anterior coxal cavities closed, except *Omophron*, have the intercoxal process of the prosternum forming a more or less abrupt declivity* at the base of the prosternum; from the basal declivity the intercoxal process extends forward and unites with the antefurca: this connection, which is explanate and flat on its upper surface, helps to strengthen the coxal cavities and support the base of the body. The term intercoxal plate has been suggested by me for this intercoxal explanate part. The connection between the point of the epimerum and the sides of the intercoxal declivity is beside the peduncle of the body and presents some differences. In *Siagona* and *Pheropsophus* the apex of the epimerum is merely applied to the declivity without being fused with it, but usually the parts are welded firmly together; in

* The African species *Morio guineensis* and *Platynodes westermanni* have the intercoxal declivity exceptionally reduced in height, and the apex of the epimerum unusually wide.

many Pterostichides the pointed epimerum is received into a notch of the intercoxal declivity.

Whether the fully closed or the open anterior cotyloid cavity is the more primitive form is a disputed subject, but probably everyone will agree that the partially closed form of *Omophron* is a link between the other two. If we consider the Omophron-form as leading forwards towards the fully closed one, we will consider the open form primitive, but if we regard it as a reduction foreshadowing a complete loss of the basal process of the prosternum we must put the fully closed cavity as the oldest one. My opinion favours the latter view, but I cannot bring forward any conclusive evidence in support of this opinion. I do not expect there will be any dissent from the view that the uniperforate is older than the biperforate form.

The middle cotyloid cavities are confluent with one another above the intercoxal plate of the mesosternum, except in the tribes Ozaenini and Promecognathini, where I have observed that each cavity is divided completely from the other by a thin chitinous partition.

Tibial spurs.—There are always two spurs attached to each tibia. The spurs of the anterior tibiae are not always similarly placed. They are truly terminal only in the tribes Ozaenini, Metriini, and Trachypachini,* though the term terminal has been applied inaccurately by authors to the spurs in other tribes. The spur at the inner side of the apex, when both spurs are terminal, is evidently that which should be called the inner spur, but it never varies in its position throughout the Carabidae. It is the spur corresponding to that which is found at the outer side of the apex where both spurs are terminal, which is always the one which varies in position. Horn habitually called the spur of variable position the inner spur, a misleading term. Except in the three tribes with both spurs terminal the term outer is inapplicable to it, but it could be called the variable spur, or spur of varying position. Seeing that the other spur is always at the outer side of the apex, when both spurs are terminal, and that when the spur of varying position is not at the apex, it is always above the apex, the term upper may be correctly applied to it, and this term is used in this paper.

Tarsi.—In most Carabidae the males have the underside

* Horn was in error in saying "inner spur above the tip" for the Trachypachini, and the "spurs distant" for the Ozaenini.

of some of the joints of the anterior tarsi bearing vesture of variable form; less frequently the middle tarsi also have vesture beneath, but only in species in which the protarsi have vesture. The vesture is usually of the same form throughout every tribe, and this is the case also throughout the great complex of the Carabidae-disjunctae; but the Harpalini may be quoted as a tribe in which two types of vesture occur, viz. the spongiose and the biseriate forms. In several tribes, and some genera, in which it is normal for the males to have vesture on some of the tarsal joints, species occur with naked tarsi; therefore, though the presence of vesture in the males is a character of high taxonomic value, the want of it does not always help to decide the position of a species.

Facies.—Horn has a good note on the value of facies "to the practised eye," but it is by no means easy even for the practised eye always to place a species by its facies, as an examination of the genera *Stenochila*, *Homothes*, and *Atranus* (not to mention others) will show.

It only remains to add that I believe that no character is so insignificant that it should not be used in classification, though only the knowledge of the expert student can tell the proper value to be placed on any feature. As far as possible, in the present state of entomological science, we should give preference to characters which may be examined without involving elaborate dissections. As knowledge increases, and accurately drawn figures become more plentiful, hidden characters will doubtless be more used. It cannot be too strongly emphasised that every badly or inaccurately drawn figure, and every careless description or diagnosis of a tribe, genus, species, or organ is a hindrance to progress.

Two new tribal names have been introduced into the table which follows, viz. Disphaericini and Amorphomerini, each with only one genus. Thirteen tribes which are not in G. H. Horn's list of tribes are recognised here, viz. Opisthiini, Notiophilini, Hexagoniini, Granigerini, Cuneipectini (Australian, one genus, two species), Merizodini (Australasian and South American, five genera, viz. *Merizodus*, *Brachydema*, *Percodermus*, *Pterocyrtus*, and *Idacarabus*), Disphaericini, Agonicini (Tasmanian, one genus, two species), *Amorphomerini* (African), Tetragonoderini, Pentagonicini, Physocrotaphini, and Zuphiini. Ten tribes to which Horn allotted full tribal value have

not been regarded as entitled to such high rank, though doubtless in most cases worthy of recognition as minor groups; these are Cychrini, Pamborini, Mystropomini, Nomiini, Psydrini, Morionini, Egini, Anchonoderini, Zabrini, and Zacotini; all are noticed in the notes following the table. The six main divisions which are now proposed are not supposed to be subfamilies, but I believe that subfamily names, about equal in value to the tribe Scaritini in its widest sense, will be found useful when the Carabidae are more thoroughly classified.

TABLE OF TRIBES

1. (32) Middle coxal cavities not entirely inclosed by the sterna; epimera of mesosternum attaining the coxae. CARABIDAE DISJUNCTAE.
2. (21) Anterior coxal cavities closed behind. CARABIDAE CLAUSAE.
3. (20) Prosternum with an intercoxal declivity, and with a longitudinal intercoxal part to support the peduncle of the body.
4. (7) Anterior tibiae with both spurs terminal.
5. (6) Mandibles without a fixed seta in scrobe. Prosternum not prolonged behind. Elytra with a process on each side. . . . . OZAENINI.
6. (5) Mandibles with a fixed seta in scrobe. Prosternum prolonged behind. Elytra simple at sides. . METRIINI.
7. (4) Anterior tibiae emarginate and with one spur above emargination.
8. (11) Upper articulation-point of mandible with head concealed by the clypeus.
9. (10) Body not pedunculate. Elytra 10-striate before apical declivity. Anterior tibiae not prolonged at outer apical angle. . . . . MIGADOPINI.
10. (9) Body pedunculate. Elytra never 10-striate. Anterior tibiae with outer apical angle prolonged. . SCARITINI.
11. (8) Upper articulation-point of mandible with head hidden.
12. (17) Antennae arising under a distinct lateral ridge. (Body *pedunculate.*)
13. (16) Mentum not supported at base by a projecting submentum.
14. (15) Anterior tibiae emarginate, upper spur distant from apex. SIAGONINI.
15. (14) Anterior tibiae obliquely grooved, upper spur set obliquely above outer one not far from apex. . ENCELADINI.

16. (13) Mentum supported at base by a projecting submentum. (Anterior tibiae emarginate, upper spur distant from apex.) . . . . PROMECOGNATHINI.
17. (12) Antennae free at base.
18. (19) Mandibles stout, a fixed seta in scrobe. Antennae not unusually setigerous. . . . . ELAPHRINI.
19. (18) Mandibles flat, rounded externally, no fixed seta present. Antennae with joints 2–6 bearing long setae projecting irregularly forward. . . . . LORICERINI.
20. (3) Prosternum without an intercoxal declivity dividing coxae behind,—base of body supported by base of prosternum. OMOPHRONINI.
21. (2) Anterior coxal cavities open behind. **CARABIDAE APERTAE.**
22. (23) Posterior coxae reaching side-margins of body. Anterior tibiae with both spurs terminal. . TRACHYPACHINI.
23. (22) Posterior coxae not reaching side-margins of body. Anterior tibiae with the spur of variable position more or less above the apex.
24. (29) Mandibles with a fixed seta in scrobe.
25. (28) Anterior tibiae obliquely grooved, upper spur near apex. Elytra with interstice 2 not unusually wide.
26. (27) Head with two supra-orbital setae on each side. Elytra tessellated. . . . . OPISTHIINI.
27. (26) Head with one supra-orbital seta on each side. Elytra not tessellated. . . . . NEBRIINI.
28. (25) Anterior tibiae emarginate, upper spur distant from apex. Elytra abnormally sculptured—interstice 2 forming a wide smooth space. . . . . NOTIOPHILINI.
29. (24) Mandibles without a fixed seta in scrobe.
30. (31) Head with one supra-orbital seta; front not bisulcate; antennae not received into a suborbital groove. Met-epimera not perceptible. . . . . . CARABINI.
31. (30) Head with two supra-orbital setae; front deeply bisulcate; antennae received at base into a suborbital groove. Met-epimera well developed. (Mandibles pluridentate.) HILETINI.
32. (1) Middle coxal cavities entirely inclosed by the sterna, epimera of mesosternum not attaining the coxae. **CARABIDAE CONJUNCTAE.**
33. (66) Anterior coxal cavities with a single opening inwards—the opening closed by the meeting of the epimerum with the intercoxal declivity. **CARABIDAE UNIPERFORATAE.**
34. (35) Maxillae with a movable hook at apex. HEXAGONIINI.
35. (34) Maxillae without a movable hook at apex.

36. (65) Maxillary palpi normal—four evident joints.
37. (56) Elytra with a plica near sides on under surface.
38. (51) Elytra with edge of inflexed margin interrupted by the inner plica towards apex.
39. (40) Head with a suborbital longitudinal ridge. GRANIGERINI.
40. (39) Head without a suborbital ridge.
41. (42) Prosternum cuneiform at base. . . . CUNEIPECTINI.
42. (41) Prosternum not cuneiform at base.
43. (48) Prothorax with posterior fixed seta, if present, at basal angle. ♂, if with any articles of tarsi clothed beneath, then not more than 1–3 of protarsi with vesture.
44. (47) Palpi not subulate.
45. (46) Maxillary palpi with penultimate joint glabrous. Antennae normally with joints 1–3 glabrous. ♂ protarsi, if with vesture beneath, normally with articles 1–3 biseriately squamose. . . . . PTEROSTICHINI.
46. (45) Maxillary palpi with penultimate joint setose. Antennae with joints 2 and 3 setulose. ♂ protarsi with vesture beneath articles 1 and 2. . . . . MERIZODINI.
47. (44) Palpi subulate. . . . . BEMBIDIINI.
48. (43) Prothorax with posterior fixed seta present but distant from basal angle. ♂ protarsi with articles 1–4 spongiose beneath.
49. (50) Body pedunculate. Prothorax globose, constricted to a very narrow short basal stalk. . . DISPHAERICINI.
50. (49) Body not pedunculate. Prothorax of normal shape. PELECIINI.
51. (38) Elytra with inner plica not visibly interrupting margin towards apex. (Head normally with one supra-orbital seta on each side.)
52. (55) Antennae with at least joints 1–3 glabrous.
53. (54) Joint 1 of antennae normal. ♂, if tarsi clothed beneath, then with spongiose vesture. . . . . BROSCINI.
54. (53) Joint 1 of antennae elongate (scapiform). ♂ protarsi biseriately squamose beneath articles 1–4. AGONICINI.
55. (52) Antennae with not more than joints 1 and 2 glabrous (rarely basal part of 3). (Prothorax normally with posterior fixed seta wanting.* Head with one supra-orbital seta on each side.) . . . . HARPALINI.

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* There is a fixed seta at the basal angles only in the genera *Diachromus* and *Dichirotrichus*; in *Gnathaphanus orientalis* Dej. there is a posterior fixed seta distant from the basal angle, as in the Broscini.

56. (37) Elytra without an inner plica.
57. (58) Mandibles with a fixed seta in scrobe. . . TRECHINI.
58. (57) Mandibles without a fixed seta in scrobe.
59. (64) Mentum arcuately narrowed from base to apex, lobes more or less pointed. Sides of head gently and obliquely narrowed to clypeus.
60. (61) Head normal. Prothorax depressed (hardly ever narrower than head). . . . . ANCHOMENINI.
61. (60) Head narrowed behind eyes (hardly ever not narrowed). Prothorax narrow (hardly ever wider than head).
62. (63) Tarsi with ungues simple. . . . . . ODACANTHINI.
63. (62) Tarsi with ungues pectinate. . . CTENODACTYLINI.
64. (59) Mentum straight at sides, lobes wide, truncate. Sides of head with a strong sinuosity at base of mandibles. CRATOCERINI.
65. (36) Maxillary palpi abnormal, apical joint rudimentary, penultimate joint large, obtuse at apex, longitudinally 3-sulcate on middle of upper and lower sides. AMORPHOMERINI.
66. (33) Anterior coxal cavities with two openings inwards. CARABIDAE BIPERFORATAE.
67. (100) Head without antennal grooves beneath.
68. (71) Mandibles with a fixed seta in scrobe.
69. (70) Elytra truncate at apex. Prothorax bordered on sides, sutures of prosternum visible. . . BRACHYNINI.
70. (69) Elytra entire at apex. Prothorax constricted to a narrow base, lateral borders and sutures of prosternum not visible. (Body pedunculate. Maxillary palpi very long and narrow.) . . . . APOTOMINI.
71. (68) Mandibles without a fixed seta in scrobe.
72. (73) Labrum with basal membrane exposed. . LICININI.
73. (72) Labrum with basal membrane concealed.
74. (77) Elytra with a plica near sides on under surface.
75. (76) Head with two supra-orbital setae in each side. Apical joint of maxillary palpi obliquely set on to penultimate. PANAGAEINI.
76. (75) Head with one supra-orbital seta on each side. Apical joint of maxillary palpi normally set on to penultimate. CHLAENIINI.
77. (74) Elytra without an inner plica.
78. (97) Antennae inserted just beneath the pre-ocular frontal ridge.
79. (96) Mes-epimerum and met-episternum not reaching middle coxal cavities.
80. (93) Antennae with joint 1 normal.

81. (82) Tibial spurs long, serrulate on lower edge of outer side. TETRAGONODERINI.
82. (81) Tibial spurs short, not serrulate.
83. (84) Spurs of anterior tibiae minute. (Head narrowed behind to a condyliform neck. Prothorax longer than broad, narrower at apex than at base.) . . . AGRINI.
84. (83) Spurs of posterior tibiae of moderate length.
85. (90) Labium with paraglossae adnate to ligula.
86. (89) Ligula narrow, paraglossae always well developed.
87. (88) Mentum supported at base by a projecting submentum. LEBIINI.
88. (87) Mentum not supported at base by a projecting submentum. PENTAGONICINI.
89. (86) Ligula wide, corneous; paraglossae normally rudimentary (in *Omphra* narrow and a little shorter than ligula.) HELLUONINI.
90. (85) Paraglossae free.
91. (92) Body pubescent. Eyes inclosed at base in large setose orbits. . . . . PHYSOCROTAPHINI.
92. (91) Body glabrous. Eyes free at base. . ORTHOGONIINI.
93. (80) Antennae with joint 1 scapiform.
94. (95) Labrum narrower than clypeus. . . . ZUPHIINI.
95. (94) Labrum wider than clypeus. . . . . . . DRYPTINI.
96. (79) Mes-epimerum and met-episternum reaching middle coxal cavities. . . . . MORMOLYCINI.
97. (78) Antennae inserted far below the pre-ocular ridge (on a level with lower side of eyes).
98. (99) Antennae inserted near eyes, lower edge of orbits emarginate anteriorly. . . . . GRAPHOPTERINI.
99. (98) Antennae inserted at a distance before eyes, orbits evenly rounded. . . . . ANTHIINI.
100. (67) Head with distinct usually long antennal grooves beneath. PSEUDOMORPHINI.

It has been thought advisable to offer the notes which follow on some of the tribes tabulated above.

OZAENINI.—The genera *Mystropomus* and *Ozaena* are contribal. Horn rightly placed *Mystropomus* (as the type of a tribe) in his subfamily Carabinae; but, misled by an erroneous interpretation of the form of the mesepimera in *Pachyteles*, he put the Ozaenini in his Harpalinae.

SCARITINI.—Horn formed a mistaken idea of the form of the epilobes of the mentum in *Schizogenius*; the parts

shown in his fig. 23, and described by him as very wide epilobes, are really the inner parts of the lobes. A somewhat similar concave mentum occurs in some species of *Clivina* (*e.g. C. dentipes*).

SIAGONINI.—This tribe belongs to Horn's subfamily Carabinae, though placed by him in his Harpalinae.*

CARABINI.—The tribe Carabini as here intended includes the tribes Cychrini and Pamborini of Horn.

HEXAGONIINI.—In his recent work on the types of Schmidt-Goebel Mr. H. E. Andrewes has shown that the view of the old authors who said that the maxillae in the genus *Hexagonia* had the inner lobe furnished with a movable hook is the correct one; my examination of the genus supports this opinion. Horn declared that the idea of a movable hook at the apex of the maxillae was an error.

GRANIGERINI.—Bedel tabulated the tribe Granigerini (under the name of Cosciniini) as being without a fixed seta in the outer scrobe of the mandibles. The scrobe is plurisetose, but I believe the fixed seta must be considered to be present. In *Melaenus*, the other genus of the tribe, the fixed seta is easily seen, there being no other setae present.

PTEROSTICHINI.—As here intended this tribe conforms more to Schaum's ideas of its limits than to Horn's, but I have excluded the Anchomenini which were included by Schaum. Horn's tribes Morionini, Nomiini, Psydrini, and Zabrini, with the Amarini of European authors, are here brought into the Pterostichini. I can see no sufficient reasons for forming a distinct tribe for the Morionides, which are linked to the Pterostichini by the genus *Catadromus*. *Nomius* and *Psydrus* † I regard as contribal; specimens of *N. pygmaeus* and *P. piceus* have been examined without any reasons being found for considering them as other than nearly related species belonging to the same group as *Melisodera* and many other Australian genera which I have ceased to regard as belonging to a tribe distinct from Pterostichini, though a group Nomiides may be admitted to take in these genera. In view of the variations in the number of the supra-orbital setae of the head in other tribes it seems a mistake to try and limit the tribe

* *Cf.* Dr. Walther Horn, Deutsch. Ent. Zeitschr., 1907, p. 428.

† Though Horn says that *Psydrus piceus* Leconte has the tarsi not differing in the sexes, I find that the male has the protarsi with 3 basal joints biseriately squamose beneath.

Pterostichini by this character, thereby excluding *Zabrus* which has only one supra-orbital seta on each side. There are a few undoubted Pterostichides with only one supra-orbital seta, and, if the genus *Amara* be admitted into the tribe (and I see no sufficient reasons for excluding it), a section of that genus has only one supra-orbital seta.*

DISPHAERICINI.—It has seemed to me wrong to include the genus *Disphaericus* in the tribe Peleciini, therefore a new tribe has been proposed for it. It has the anterior coxal cavities with a single opening inwards, head with two supra-orbital setae on each side, three basal joints of antennae pubescent, posterior coxae divided, etc. Probably *Disphaericus* and *Pelecium* are the most archaic genera of the Carabidae-uniperforatae.

BROSCINI.—The inclusion of the numerous genera of the southern hemisphere in this tribe gives it much wider limits than as diagnosed by Horn; therefore, I think it may well include his Zacotini, founded on the monotypic genus *Zacotus*, which is unknown to me in nature.

HARPALINI.—My ideas of this tribe agree with Horn's with the exception of his inclusion of the genus *Glyptus*, which belongs to the Orthogoniini, as Schaum saw. I include here the Amblystomides, about the position of which group there have been differences of opinion, and on which a distinct tribe has been founded.

TRECHINI.—The tribe as here tabulated agrees with Horn's Pogonini. I regard Trechini as the name to be adopted as corresponding to Bonelli's stirps Trechii and therefore entitled to priority.

ANCHOMENINI.—I am in accord with Horn and Tschitscherine in recognising the validity of this tribe, which has been merged with the Pterostichini by Schaum and European authors generally. I follow Horn, though with some doubt, in referring Chaudoir's Masoreides and Bates's Perigoninae to the Anchomenini as subtribes. Horn's term for the tribe is Platynini, but I think Anchomenini has priority.

* In Horae Ent. Soc. Ross., xxxv, 1902, p. 532 (*note*), Tschitscherine recorded that he knew of four species of the great genus *Pterostichus* with abnormal supra-orbital setae, viz. the subgenera *Haptotapinus* and *Chaetauchenium*, with one seta on each side, and two species of the subgenus *Amolops* with five or six. His note also gives the facts about the supra-orbital setae in *Amara* which I have recorded above.

ODACANTHINI.—I merge with the Odacanthini the Anchonoderini and Horn's tribe Egini. I would also place here the genus *Stenochila*, which has the anterior coxal cavities with a single opening inwards.

CTENODACTYLINI.—I would place in this tribe the South American genera *Plagiotelum* and *Calophaena*, both of which have the anterior coxal cavities with a single opening inwards.

CRATOCERINI.—The genus *Cratocerus* is unknown to me in nature; the tribe has been tabulated from the genus *Basolia*.

AMORPHOMERINI.—This new tribe is founded on a new generic name which is now proposed to take the place of *Trimerus* Chaudoir (1878), which was preoccupied. It is a monotypic tribe, and perhaps the most aberrant in the whole family. Chaudoir saw that it required a new group, but, not knowing the male, he refrained from giving a decided opinion as to its position, merely suggesting that perhaps it came after Oodes. Its affinities seem to me more towards the Pterostichini; I have placed it at the end of the Carabidae-uniperforatae on account of its extremely isolated position. I do not accept Chaudoir's diagnosis of his genus in every particular, especially with reference to the maxillary palpi, which he thought were 3-jointed, but I have clearly seen the rudimentary apical joint inserted in the apex of the abnormal penultimate joint.

Amorphomerus, gen. nov.

Middle coxal cavities entirely inclosed by the sterna, mes-epimera reaching the coxae. Anterior coxal cavities fully closed and with a single opening inwards. Ligula corneous, a little longer than broad, obliquely angustate to apex from anterior third; apex wide, trisinuate, armed with a small mandible-like horn at each external angle; outer side bearing a median keel triangularly bifurcate before apex, triconcave (one apical concavity between the branches of the keel, and a basal one on each side to receive joint 1 of the palpus). Paraglossae cartilaginous, attached to under side of ligula, but not reaching to its apex. Labial palpi with penultimate article rather narrow, elongate, bisetose on inner side; terminal article widely cultriform. Maxillary palpi abnormal, stout; article 2 stout, bowed, incrassate; article 3 large, elongate, much longer and stouter than 2, obtuse at apex, setigero-punctate, upper and lower sides longitudinally 3-sulcate in middle, median sulcus wide,

deep, punctate; article 4 rudimentary, reduced to a small nodule-like appendage inserted in apex of 3. Maxillae bilobed. Antennae with articles 1–3 glabrous. Head with one supra-orbital seta on each side; front closely punctate. Prothorax closely punctate, two submarginal fixed setae on each side, the posterior one distant from basal angle. Elytra with a striole at base of interstice 2; stria 9 well developed and distant from border posteriorly; margin strongly sinuate on each side before apex, not interrupted by an inner plica, ♂ protarsi with articles 1–3 dilatate and biseriately squamose beneath.

CHLAENIINI.—I would place in this tribe the Oodides as a subtribe, also the genera *Callistus*, *Atranus*, and *Lomasa* (1919). I have examined *Atranus collaris* Menetr., and *Lomasa xanthacrus* Wied., and found the anterior coxal cavities biperforate inwards. *Atranus* cannot be referred to the Pterostichini, as is done by European authors, nor to the Anchonoderides, as by Horn. *Lomasa xanthacrus* is not a Lachnophoride, as thought by Chaudoir.

TETRAGONODERINI.—I think this tribe should be accepted. *Corsyra* must be included here; it has the anterior coxal cavities biperforate, and at least the spurs of the middle tibiae coarsely serrulate on inner edge.

LEBIINI.—Since Horn's monograph was published the tribes Tetragonoderini and Pentagonicini have been removed from his Lebiini, otherwise the tribe is here the same as with him. Chaudoir and Bates used many named groups in this tribe, but their groups seem either not to have been defined, or defined in a way that was not conclusive. I formerly suggested a separate tribe for *Miscelus*, but now I am not sure of its validity. Until all those Carabidae which Horn grouped together in his tribe Lebiini are more thoroughly understood, the status of existing groups, and others which may be required, will be obscure.

PHYSOCROTAPHINI.—The three genera of this tribe are *Physocrotaphus*, *Helluodes*, and *Pogonoglossus*.

ORTHOGONIINI.—*Glyptus* belongs here. It has the anterior coxal cavities biperforate.

Supplementary Note to The Classification of the Carabidae.

By Thomas G. Sloane.*

Pterostichini.—On page 248 of my paper on "The Classification of the Carabidae" (these Transactions, 1923) I published a footnote purporting to give the views of Tschitschérine, in 1902, on the variations in number of the supra-orbital setae in the tribe Pterostichini, but my interpretation of his footnote 55 (Hor. Soc. Ent. Ross, xxxv, 1902, 532) was erroneous in regard to the subgenus *Chaetauchenium* (type *Platysma convexipenne* Fairm., 1860, Chili). I find that Tschitschérine in his diagnosis of *Chaetauchenium* (*op. cit.*, xxxiv, 1900, 461) says : "Tête . . . avec à chaque orbite les deux pores sétigères ordinaires et, en outre, un ou deux pores supplémentaires placés apres le deuxième et davantage vers l'intérieur." This leaves the Palaearctic *Haptotapinus* (2 species) as the only genus of the typical section of the Pterostichini known to me as having but one supra-orbital seta on each side. It may be of interest to note that in the Australian genus *Trichosternus* (23 species) there are three species in which the supra-orbital setae vary from the normal number of two, viz. *T. cyaneocinctus* Boisd., and *T. superbus* Cast., with three setae, and *T. setosiceps* Sl., with four setae on each side.

Dercylini.—I give below a short diagnosis of a new tribe that is required for the genera *Dercylus*, *Asporina*, and *Physomerus* of South America. I include Chaudoir's genus *Dercylodes* in *Dercylus*; *Physomerus* is unknown to me in nature.

Middle coxal cavities entirely inclosed by the sterna, mesepimerum not attaining the coxae. Anterior coxal cavities closed and with a single opening inwards. Head stout, not constricted behind eyes; orbits small behind eyes; front with two rather deep parallel impressions; eyes distant from buccal fissure beneath; one supra-orbital seta on each side. Antennae rather stout, arising under a strong frontal ridge; joints 1–3 and base of 4 glabrous, 2 short, 3 subequal with 1. Labrum 6-setose, median pair of setae near

* This supplement and list of corrigenda were received from the Author after the publication of the original paper.—[H.E.]

together. Prothorax with a strongly impressed elongate sulcus on each side of base; two fixed marginal setae on each side, posterior seta at basal angle. Elytra striate; a scutellar striole at base of interstice 1; interstice 3 without fixed setiferous punctures; base bordered; margin interrupted towards apex and with a distinct inner plica. Posterior coxae contiguous. ♂, protarsi with joints 1–3 widely dilatate and spongiose beneath, joint 4 small, emarginate—in *Dercylus* united with joint 3 at outer side of apex, in *Asporina* at middle of apex.

The following particulars are added from an examination of *Dercylus crenatus* Schaum.

Mentum deeply emarginate; sinus oblique on sides; epilobes narrow, a little prominent but obtuse at apex. Ligula broad, corneous; apex with two distant setae; under surface keeled, a shallow longitudinal groove on each side to receive the elongate basal piece of the palp. Paraglossae cartilaginous, glabrous, small, not extending beyond ligula, adnate with ligula for three-fourths of length; apical fourth free and very narrow, pointed at apex. Labial palpi stout; penultimate segment short, asetose; apical segment a little longer than penultimate, thick, truncate. Maxillae short, hooked at apex; outer lobe stout, biarticulate. Maxillary palpi with segment 2 stouter and longer than others; 3 and 4 not long, equal, stout, 3 narrowed to base, 4 thicker than 3, truncate. Elytra with interstice 9 merged in lateral channel.*

The affinities of these genera have been misunderstood, but the uniperforate anterior cotyloid cavities indicate their position, which I believe to be very near to the tribe Peleciini. Some conspicuous differences from the Peleciini are—head not constricted to a neck behind eyes; prothorax with posterior marginal seta at basal angle; posterior coxae not separated; labium with paraglossae not ciliate within, not extending beyond ligula; maxillae hooked at apex.

In his "Monographie des Oodides" (Ann. Soc. Ent. Fr., 1882 and 1883) Chaudoir referred the genera on which I have constituted the tribe Dercylini to the Oodides with some hesitation, for he says (p. 528): "dans aucun vrai Oodien on ne voit les profonds sillons sur le front et sur

* The loss of the ninth interstice is found throughout the tribes Hiletini, Scaritini, and Peleciini, and also occurs in some members of the tribe Pterostichini, *e. g.*, genus *Paranurus*, and a few species of the genus *Trichosternus*.

les côtés de la base du corselet qu'on trouve dans les *Dercylus* et les deux genres qui suivent."

CORRIGENDA.

Page 235, line 31, for *Coplolobus* read *Coptolobus*.
Page 238, line 40, *for* six forms *read* five forms.*
Page 238, line 41, delete (1).*
Page 238, line 44, *for* (2) *read* (1).
Page 239, line 4, „ (3) „ (2).
Page 239, line 5, „ (4) „ (3).
Page 239, line 9, „ (5) „ (4).
Page 239, line 15, „ (6) „ (5).
Page 240, line 37, „ outer side *read* inner side.
Page 242, table, section 11 (8), *for* hidden *read* not hidden.
Page 242, table, section 15 (14), *for* outer *read* inner (terminal).
Page 246, table, section 83 (84), *for* anterior tibiae *read* posterior tibiae.
Page 248, footnote, *Chaetauchenium* has more than two supra-orbital setae (see above, under Pterostichini).

Moorilla, Young, N.S.W., 8.10.23.

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* I only know of five forms of the anterior cotyloid cavities, the closed form when first mentioned should not have had a number assigned to it.—T. G. S.

X. *Observations on the Growth of the Larva of the Puss Moth,* Dicranura vinula *F.* By George B. Walsh, B.Sc. Communicated by E. C. Bedwell.

[Read May 2nd, 1923.]

In an attempt to gain some idea of the rate of growth of a lepidopterous larva, a score of larvae of the Puss Moth were reared from the egg to the pupa; each day at the same hour they were measured with a millimetre rule, from the anal extremity, neglecting the tails, to the head, and weighed on a delicate chemical balance, reading to 0·0001 gram. Owing to the fact that the larvae moulted at different intervals,* it was found very difficult to average the results, the difficulty being increased by sexual differences of growth. It was found better to collate the results from one example, and consequently the following conclusions apply to a fairly typical female, whose numbers referring to length, weight, times of moulting and age are a pretty good average of the fourteen specimens which completed their larval life. Each larva was reared separately in a well-ventilated small cage,

Table I.

Week.	Day.						
	1	2	3	4	5	6	7
I	15	18	26	37	54	77	73
II	71	71	70*	177	223	292	276
III	274	247*	352	468	623	792	992
IV	1395	1541	1470	1452	1411	1336*	1665
V	2073	2262	2834	3495	4772	5403	6451
VI	6982	6686	6653	6219*	7986	9392	12600
VII	15118	17868	21731	26922	29646	30162	33123
VIII	34981	36180	37876	38442	41313	40363	39311
IX	36503*	← Spun up →					

Weight of Puss Moth larva (·0001 gm.).

* In two extreme cases, the moults and pupation took place after 9, 16, 27, 39, and 53 days; and 8, 15, 27, 44, and 73 days respectively, the former being a female and the latter a small male.

intended to prevent as far as possible all wandering from the food-plant with consequent loss of feeding. The food consisted of sallow, plugged in a small vessel of water, and both food-plant and water were changed every day. Presumably owing to the care taken in this way, the

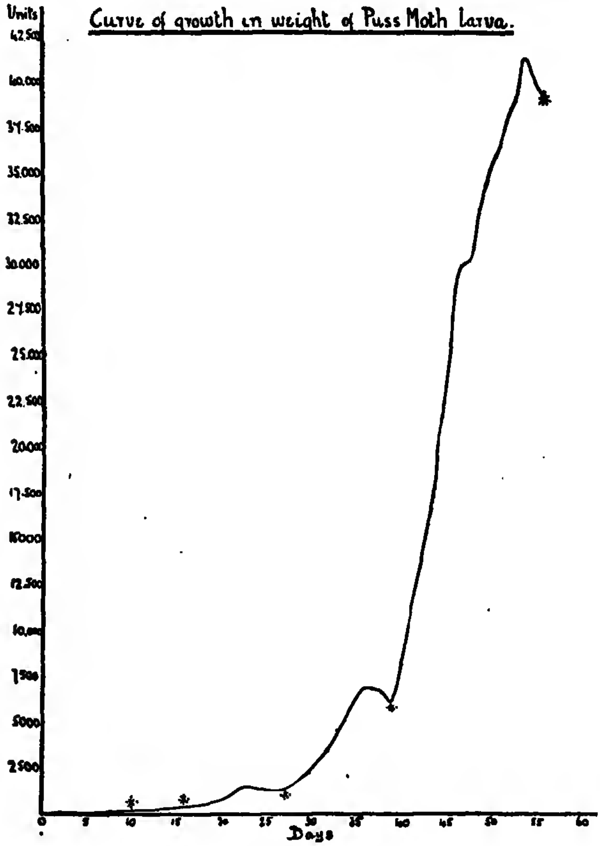


Fig. 1.

larvae were kept quite free from disease. Two of the six deaths were due to escapes, and the other four were due either to accidental damage sustained when the caterpillar was being removed from the silken pad in which it had entangled its pro-legs prior to ecdysis, or to the inability of the moulting larva to escape from its exuvium after such removal.

The weights are recorded in Table I, each unit representing ·0001 gram. Throughout the tables and diagrams, a moult is represented by an asterisk (*). An attempt has been made to represent these results diagrammatically in Fig. 1, but, owing to the small scale which has had to be employed, the lower part of the curve unfortunately

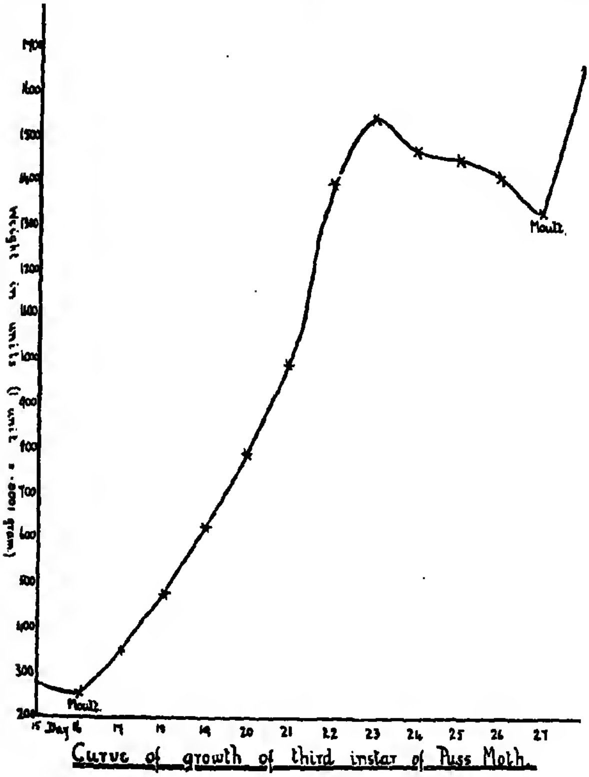


FIG. 2.

shows no detail. The most obvious conclusion is that the Puss Moth larva just prior to pupation is about 2,400 times its weight on the first day of its active life, as compared with a total increase for man of about 20 times. The difference is, of course, due to the fact that a human being undergoes a considerable amount of growth while in the intra-uterine stage, while lepidopterous eggs, owing

to their enormous numbers, contain relatively little nourishment for the embryo.

The numbers and to a less extent the curve show clearly the larval instars—in this case five—and in the last instar the occurrence of a distinct break in the rate of growth on the 48th day.

In Fig. 2 the figures for a single instar have been represented graphically on a much bigger scale; and from this it is possible to recognise clearly the four subdivisions into which an instar naturally resolves itself.

(*a*) A period of rapid growth, of shorter duration in the early instars and of relatively much longer duration in the last instar.
(*b*) Cessation of feeding * and growth, and complete emptying of the alimentary canal of all food and excreta; it was interesting to note that in practically every case of the dozens observed the last particle of frass was pink or red. This stage occupied one day or less.
(*c*) A period without feeding accompanied by relatively small loss of weight. During this stage the larva remained quite quiescent, and the loss of weight was due to respiration and transpiration. (In the case of a larva this seems a more appropriate term than perspiration.)
(*d*) Relatively heavy loss of weight, due to ecdysis.

In Table II the numbers represent the increase or decrease of one day's weight on that of the previous day; and these yield interesting quantitative values for the four stages of the instar.

(*a*) The rate of growth is most rapid during the first instar, and least rapid during the last.
(*b*) The break in the graph on the 48th day reveals itself as a marked decrease in the rate of growth; this second sub-period in the fifth larval instar is doubtless accompanied by marked internal developments preparatory to the profound changes associated with pupation.
(*c*) The rate of growth varies somewhat, although it was not possible from my observations to trace

* In one case a caterpillar in its fifth instar was observed to be feeding greedily on the day before it started to spin its cocoon.

anything more than a very rough dependence on the weather. If we consider only the days on which there was actual growth, and neglect the second sub-period of the fifth instar, which in a sense is scarcely larval but rather preparatory to the imaginal life, the average rate of growth for the 32 days of actual feeding between the 1st and the 48th is 0·30, comparing the increase in 24 hours with the weight for the previous day. Expressed mathematically, the weights during the actual feeding during any one larval instar lie on a curve which can be represented by the general formula—

$$y_x = ar^x$$

where

y_x = the weight at the end of the xth day of the instar.
a = the weight immediately after ecdysis.
r = the general ratio deduced above— *i. e.* 1·30.
x = the number of days which have elapsed since ecdysis.

Such a graph is an example of a logarithmic curve.

TABLE II.

Week.	Day.						
	1	2	3	4	5	6	7
I	←→	0·20	0·44	0·42	0·46	0·42	−0·05
II	−0·02	0·00	−0·01*	1·53	0·26	0·31	−0·05
III	−0·01	−0·09*	0·42	0·33	0·31	0·27	0·25
IV	0·41	0·10	−0·04	−0·01	−0·03	−0·05*	0·25
V	0·24	0·09	0·25	0·23	0·33	0·13	0·19
VI	0·08	−0·04	−0·01	−0·06*	0·28	0·18	0·35
VII	0·20	0·18	0·22	0·24	0·10	0·02	0·10
VIII	0·06	0·03	0·04	0·02	0·07	−0·02	−0·02
IX	−0·07*	←					→

Daily fractional increase in weight of Puss Moth larva.

(*d*) The average loss of weight preparatory to ecdysis is on the average 0·05 of the body weight, *i. e.* the alimentary canal contains 0·05 of the total weight.

The material present in the canal consists of fresh food at the buccal end and of waste at the anal extremity. Thus the value in *fresh* food of the material filling the alimentary canal is $0{\cdot}05 \times 1\frac{1}{2}$, *i. e.* 0·075 of the body weight. If we take the conservative estimate that the weight of fresh food eaten is twice the body increase, the weight of food eaten per day is 0·60 of the body weight. Hence the alimentary canal is completely emptied 8 times every 24 hours, or, in other words, the average time for food to pass from mouth to anus is, probably as an outside estimate, only 3 hours.

(*e*) The loss of weight during the days following the emptying of the gut and immediately preceding ecdysis is on the average 0·02 of the body weight. This is due to loss of carbon dioxide and water vapour, and may probably be taken as the approximate factor for every day of the larval life.

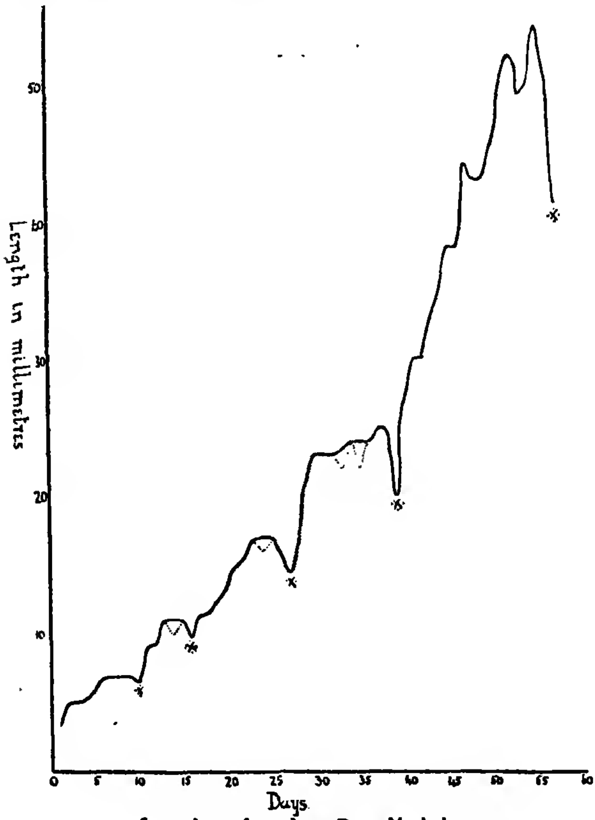
Table III

Week.	Day.						
	1	2	3	4	5	6	7
I	3·25	5·25	5·25	5·5	6·0	7·0	7·0
II	7·0	7·0	6·5*	9·0	9·5	11·0	10·0
III	11·0	9·75*	11·5	11·5	12·5	13·5	15·0
IV	15·5	17·0	16·0	17·0	16·0	14·5*	16·5
V	21·0	23·0	23·0	23·0	22·0	24·0	22·0
VI	24·0	25·0	25·0	20·0*	27·0	30·0	30·0
VII	33·0	35·0	38·0	38·0	44·0	43·0	43·0
VIII	46·0	50·0	52·0	49·0	50·0	54·0	51·0
IX	41·0*	←					→

Growth in length of Puss Moth larva (Unit = 1 mm.).

Table III shows the values obtained for the length each day, these quantities being represented graphically in Fig. 3. The result obtained depended somewhat on the attitude of the larva, but as far as possible all the numbers refer to similar positions; and in the diagram the graph has been slightly amended to correct errors

obviously due to change of position. The graph shows clearly once more the five instars, each consisting of a period of rapid growth, then a pause (without, however, any shrinkage in length and sometimes with an increase), followed by a relatively great shrinkage, and finally the moult.



Growth in length of Puss Moth Larva

FIG. 3.

The daily fractional increase in length is, of course, much less than that for weight. Since mass is proportional to the cube of the length, the factor for length should be $\sqrt[3]{1{\cdot}3}$, *i.e.* 1·09. The actual experimental result obtained as an average for the 32 days mentioned before is 1·11, which, considering all the sources of error, seems a sufficiently close approximation.

XI. *Thysanura, Termitidae and Embiidae collected in Mesopotamia and N.W. Persia by W. Edgar Evans, B.Sc., late Capt. R.A.M.C., and Dr. P. A. Buxton.* By F. Silvestri. Communicated by K. J. Morton.

[Read May 2nd, 1923.]

Plates VII–X.

In this note are recorded 7 species of Thysanura, 3 of Termitidae and 2 of Embiidae, chiefly collected during 1918–19.

Of the 7 species of Thysanura two are new and of these the species of *Lepisma* is very remarkable for the presence on the eighth abdominal tergite of a tuft of rigid setae, which bears a relation, very probably, to its myrmecophilous habit.

Ordo THYSANURA.

Fam. Lepismidae.

Lepisma evansi sp. n.

(Tab. VII.)

Corpus (in alcool et squamis denudatum) ochroleucum, thorace quam caput et quam abdominis basis aliquantum latiore, abdomine gradatim angustiore, squamis? (in exemplis typicis omnibus abruptis !).

Caput antice setis sat numerosis robustis in apice incisis et setis brevioribus attenuatis instructum, supra ante oculos setis robustis 4–5 longitudinaliter uniserialis, oculis sat parvis, antennis (in exemplis typicis haud integris) medium corpus haud attingentibus articulo primo c. $\frac{1}{3}$ longiore quam latiore, articulis ceteris a decimo quarto in articulinis duobus gradatim magis elongatis divisis, setis et sensillis vide tab. VII, fig. 2. Mandibularum stipites setis numerosis robustis in apice incisis instructi; palpi maxillares? (in exemplis typicis abrupti); palpi labiales articulo ultimo paulo longiore quam ad apicem latiore.

Thorax quam abdomen c. $\frac{2}{8}$ brevior et quam ejusdem basis c. $\frac{2}{7}$ latior; tergitorum margine laterali macrochaetis nonnullis, margine postico macrochaetis nullis, pro macrochaetis setis minimis paucis

instructo, pronoto sensillis longis duobus sublateralibus, meso- et meta-noto sensillo longiseto sublaterali postico et sensillo longiseto postico sublaterali instructis. Metasterni pars mediana subcordiformis, parum ad basim latior quam longior, postice rotundata, setis vide tab. VII, fig. 4.

Pedes sat longi, paris tertii setis et spinis vide tab. VII, fig. 5.

Abdomen tergitis macrochaetis posticis 2 + 1 + 1 + 1 + 1 + 1 + 1 + 2 nec non setis numerosis brevibus et seta breviore inter setas breves instructis, tergito 8° medio postice setis numerosis robustis sat longis acervatis aucto. Tergitum decimum parum minus quam duplo longius quam ad basim latius, lateribus parum convergentibus postice profunde sinuatum, angulo postico macrochaeta longa aucto.

Urosternum primum postice medium parum productum setis duabus brevibus et seta breviore instructum; urosternum secundum setarum pectine lato mediano; urosterna 3–8 setarum pectinibus tribus quorum medianum aliquantum latius est.

Stili in segmentis 8° et 9° (in exemplis typicis abrupti).

Subcoxae urosterni 8[i] angulatim externe et interne aliquantum productae; subcoxae urosterni 9[i] parte apicali interna longa angustata apice acuto quam interna circa duplo longiore.

Penis brevis crassus; paramera perparva.

Cerci? (in exemplis typicis maxima pro parte abrupti).

Long. corp. mm. 12, lat. thoracis 3, long. antennarum certe haud integrarum mm. 5, palpi maxillaris ?, pedum paris tertii 4, cercorum ?

Habitat. In an ants' nest at Jebel Hamrin, N.E. of Bagdad, November 1918 (*Evans*).

Observatio. Species haec urotergitorum setarum posticarum numero et dispositione, urotergiti 8[i] setis medianis numerosis acervatis distinctissima est.

Isolepisma kraepelini (Esch.).

Syn. *Ctenolepisma kraepelini* Esch., Syst. Lepesm. 1905, pp. 90–91, fig. 37.

A young female of this species was collected by Dr. Buxton under a palm near Amara.

This species was known until now only from Greece.

Ctenolepisma longicaudata Esch.

Mensil (North Persia) and Haifa (Palestine, in houses), collected by Dr. Buxton.

Ctenolepisma kervillei Silv.

I associate with this species two young specimens collected by Capt. Evans at Jebel Hamrin in 1918.

Thermobia domestica (Pack.).

Amara and Bagdad. Dr. Buxton remarks "common in houses."

Lepidospora buxtoni sp. n.

(Tab. VIII–IX.)

Corpus stramineum.

Caput antice setis numerosis brevibus et macrochaetis nonnullis, lateraliter setis brevibus, parum numerosis et macrochaetis nonnullis instructum, cetero squamis vestito.

Antennae in exemplo typico haud integrae, articulo primo parum minus quam duplo longiore quam latiore, setis et sensillis partis proximalis vide tab. VIII, figs. 2. 3. Palpi maxillares tenues, longi; palpi labiales articulo ultimo aliquantum longiore quam latiore.

Thorax quam caput parum latior et quam abdominis pars basalis etiam parum latior, tergitis posticis setis minimis paucis, lateraliter postice seta robusta sat longa et margine cetero laterali setis brevibus et setis sat longis 2–3 instructis; meso- et meta-noto utrimque antice setis sat numerosis brevibus robustis etiam instructis.

Pedes paris tertii vide tab. VIII, fig. 6.

Abdomen postice gradatim aliquantum angustius, tergitis praeter squamas margine postico laterali macrochaeta longa robusta et setis nonnullis sat longis et aliis brevibus, margine postico setis nonnullis brevissimis instructo, tergito decimo aliquantum ad basim latiore quam longiore, lateribus convergentibus margine postico sat profunde sinuato, angulo postico macrochaeta longa, robusta instructo, sternito primo triangulari acuto, subcoxis setis paucis brevibus lateralibus et aliis submedianis, sternitis 2–7 postice setis 4 brevibus medianis et setis nonnullis sublateralibus et lateralibus instructis, segmenti octavi sterno subsemiovali; vesiculis subcoxalibus in segmentis 2–7, stilis in segmenti 2–9 sistentibus, stilorum setis vide tab. VIII, fig. 2. Ovipositor crassiusculus, attenuatus apice acuto, pesudoarticulatus, stilorum IX apicem attingens.

Cerci attenuati, in exemplo typico haud integri quam corpus breviores, partis proximalis setis et sensillis vide tab. VIII, fig. 11.

Long. corp. mm. 6; lat. thoracis 1·4, long. palporum maxillarium 1·26, antennarum?, pedum paris tertii 2·70, ovipositoris 0·85, cercorum?.

Antennarum articulus secundus parte apicali interna in processum crassiusculum brevem ut tab. IX, figs. 3, 4, demonstrat, instructo.

Urotergitum decimum ab ejusdem feminae angulis posticis longioribus, angustioribus et setis nonnullis praecalibus instructis differt.

Penis brevior; paramera longa, vix clavata.

Habitat. Mesopotamia: Amara (*P. A. Buxton*).

Observatio. Species haec ad *L. escherichi* Silv. proxima est, sed thoracis et abdominis setis marginalibus dorsalibus, praeter lateralis, brevissimis, feminae urotergito decimo minus profunde inciso, maris antennarum articuli secundi apice interno aliquantum producto bene distincta est.

Fam. Japygidae.

Japyx gigas Brauer, var. **syriaca** Silv.

Specimens were collected by Capt. Evans at Jebel Hamrin and by Dr. Buxton at Amara. This form was founded by me on specimens from Syria; I have specimens collected by Dr. Buxton at Jerusalem (Palestine) also.

Ordo ISOPTERA.

Fam. Termitidae.

Hodotermes vagans Hag.

A few workers and winged from near Ruz, N.E. of Bagdad and near Kasri Shirin, N.E. Persia (*Evans*).

Hamitermes vilis (Hag.).

Workers and winged taken under a stone at Jebel Hamrin, N.E. of Bagdad, November 1918 (*Evans*).

Microcerotermes diversus Silv.

Winged and workers at Amara on the Tigris (*Evans and Buxton*).

Ordo EMBIOPTERA.

Fam. Embiidae.

Oligotoma nigra Hag.

Winged at light and under a clod of earth at Amara, August 1918 (*Evans*).

Embia persica.

I associate with this species immature females and winged males collected at light and under a clod in a garden at Amara in 1918 (*Evans*).

This species requires comparison with *Embia savignyi*, of which it may be only a variety. The males seen by me differ from those of *E. savignyi* from Egypt, apparently in the apex of the basal part of left cercus being shorter and not arched and in the first joint of the same cercus being more prominent internally (cf. tab. X).

Explicatio Tabulorum.

Tab. VII.

Lepisma evansi: 1. animal pronum; 2, antennae pars proximalis; 3. palpi labialis pars distalis; 4. metasterni pars mediana; 5. pes paris tertii; 6. ejusdem tibiae pars apicalis; 7. urotergiti quinti dimidia pars; 8. urotergiti octavi pars mediana et lateralis; 9. ejusdem penicilli mediani seta; 10. urotergitum decimum; 11. urosternum quintum; 12. urosterna 7^{um} ad 9^{um} cum pene.

Tab. VIII.

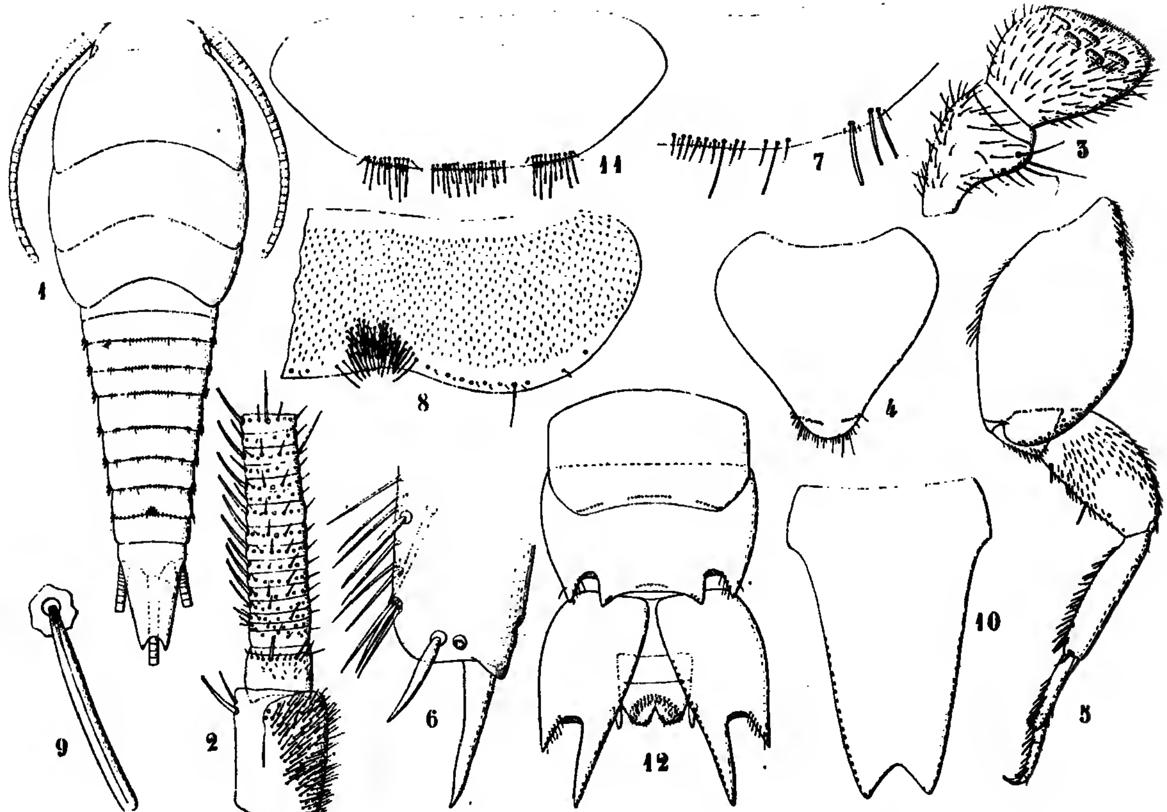
Lepidospora buxtoni, femina: 1. corpus pronum; 2. antennae pars proximalis prona; 3. eadem supina; 4. palpus maxillaris; 5. palpus labialis; 6. pes paris tertii; 7. ejusdem tibiae pars apicalis; 8. urotergiti quinti dimidia pars; 9. urotergitum decimum; 10. urosterna primum et secundum; 11. cerci lateralis pars proximalis.

Tab. IX.

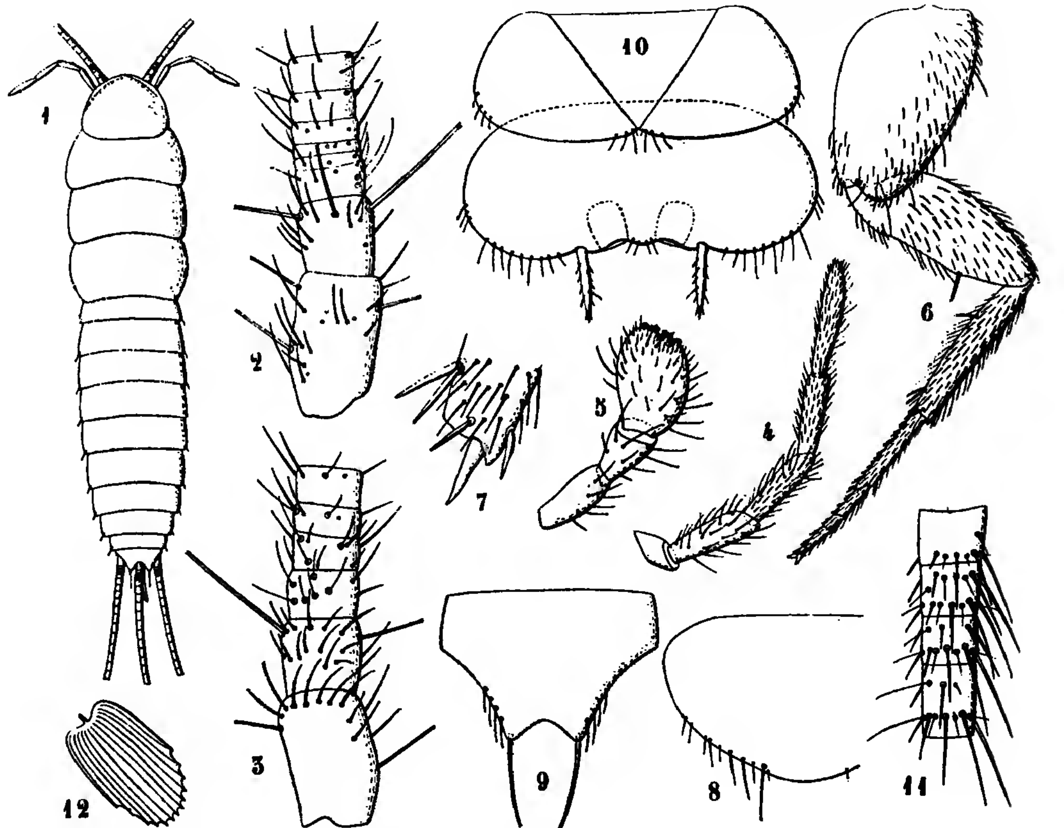
Lepidospora buxtoni: 1. urosterna septimum ad nonum cum ovipositore; 2. stilus nonus; 3. maris antennae laevae pars proximalis prona; 4. eadem supina; 5. maris urotergitum decimum; 6. urosterna 7^{um} ad nonum cum pene et parameris.

Tab. X.

Embia persica, mas.: corporis pars postica supra, lateraliter et subtus inspecta.



Hislop & Day.



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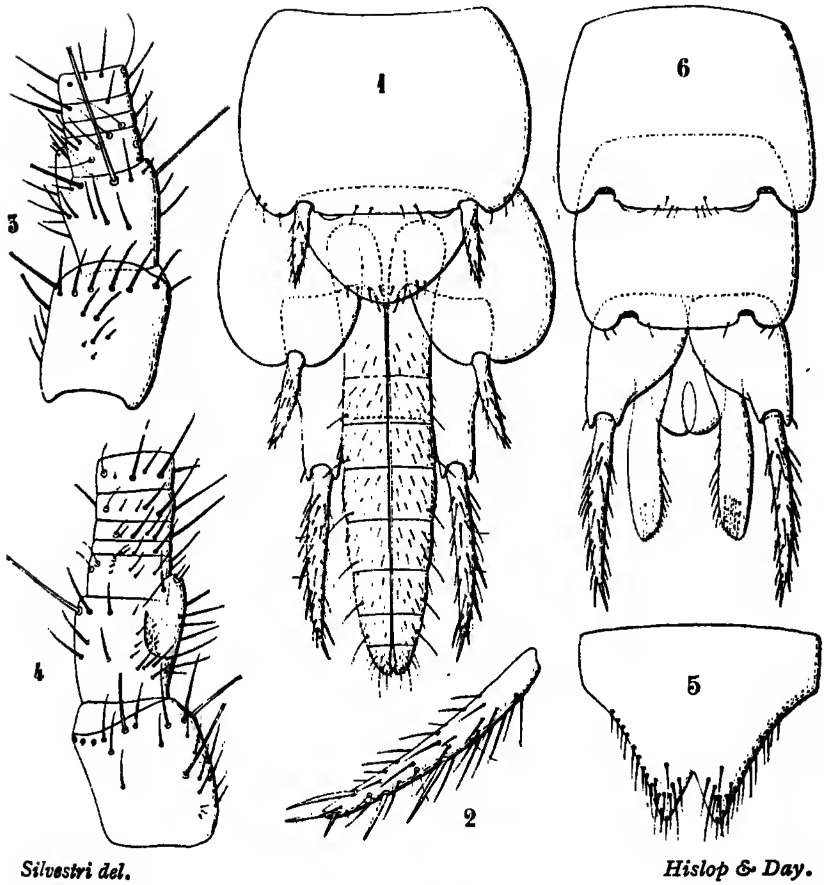
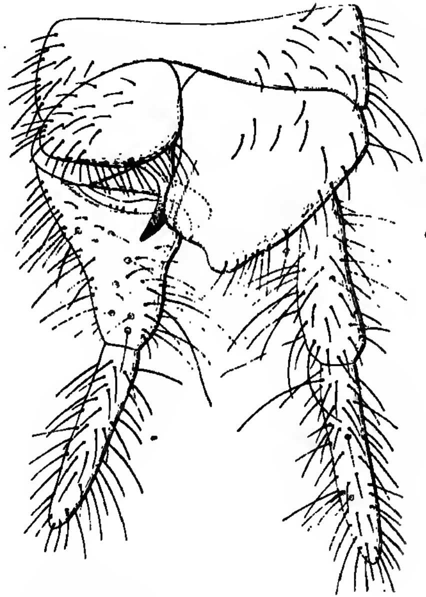
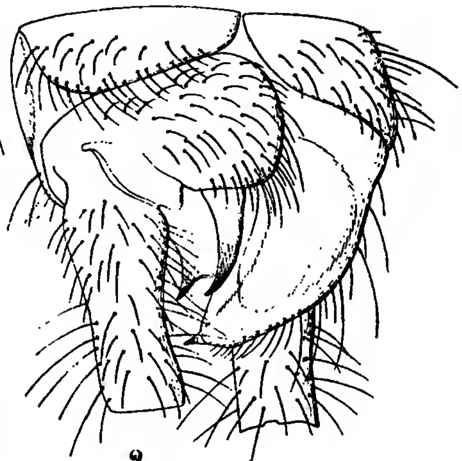


Silvestri del. *Hislop & Day.*

LEPIDOSPORA BUXTONI *Silvestri.*





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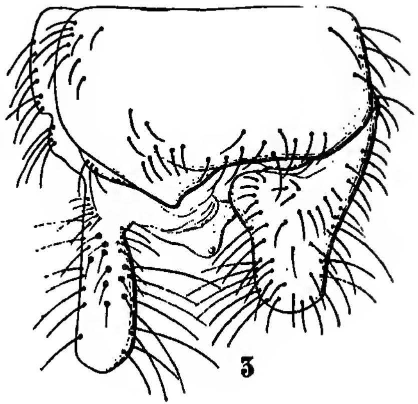

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Silvestri del. *Hislop & Day.*

EMBIA PERSICA, ♂.

XII. *On the Larva of* Pterocroce storeyi, With. (Nemopteridae). By H. Eltringham, M.A., D.Sc., with additional notes by E. N. Willmer and C. B. Williams.

[Read May 2nd, 1923.]

Plate XI.

At the meeting of the Society held on November 1st, my friend Prof. Poulton exhibited living examples of a curious creature found in caves in Egypt. The specimens had been brought to the Hope Department by Mr. E. N. Willmer of Corpus Christi College, Oxford. Prof. Poulton subsequently handed them to me for further examination, and I have made a drawing of the insect, which is reproduced on the accompanying plate.

A similar creature was rather fully described some sixty-five years ago by Schaum, though the first notice of such an insect is in a letter from M. Roux to the Baron de Férussac, written at Thebes in Feb. 1832, and published in the Ann. des Sci. Nat., vol. xxviii, 1833. In this letter M. Roux says: "I have come across an animal so extraordinary, so peculiarly formed, that before constituting a genus of the apterous hexapods, I send you a drawing of it. I found it running on the sand which encumbers the interior of the tombs in the rock in the vicinity of the Pyramids of Giseh. I name it *Necrophylus arenarius*."

Baron Férussac in a footnote says: "Is this singular creature not rather the larva of some insect, perhaps a Mantispa or Raphidia? This could not be determined from the author's drawing, which leaves much to be desired. Examination of the example itself will doubtless throw some light on this curious point."

The drawing referred to is evidently incorrect in several details. The position of the front legs is wrong, and the shape of the body is not fully indicated, whilst a slightly enlarged drawing of the head shows a structure of the mandibles and antennae not found in the specimens examined by the writer, nor, evidently, in those described by Schaum.

Roux' figure was copied by Westwood in the Introduction to the Modern Classification of Insects, vol. ii,

p. 56, f. 66, 1 (1840). Westwood states on p. 55 that it appears to him "to be a Neuropterous larva, exhibiting considerable affinity with the larvae of the Hemerobiidae. If the relation of the Nemopterae with that family be proved, is it possible that this may be the larva of that genus?"

Schaum's paper which appeared in 1857 was evidently unknown to the late Dr. Sharp, whose figure in the Insecta of the Cambridge Natural History is admittedly copied from that of Roux. The figure in the Genera Insectorum (Neuroptera) is taken from Schaum. The larva is mentioned also in Cassell's Natural History, vol. vi, p. 13, and by Lefroy in Indian Insect Life, p. 152, with a drawing which again is copied from Roux. Lefroy states that a similar insect was found in a house in India.

The only extensive account is that of Schaum, in Berl. Ent. Zeit., vol. i, pp. 1–9 (1857). That author's specimens were obtained in Feb. 1852 in the tombs of Beni Hassan, 200 feet above the level of the Nile. He obtained twenty examples, but could discover nothing of the habits of the insects beyond that they lived on the surface of the debris, and moved with equal facility both forwards and backwards. I may add that they can also move sideways with some agility.

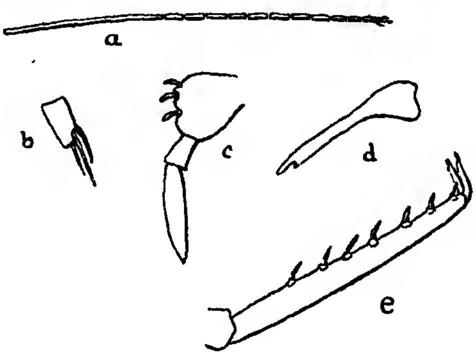
The accompanying plate illustrates the general appearance of the creature. The specimen from which it was drawn was about 8·5 mm. in length from the tips of the jaws to the extremity of the abdomen. The surface is sparsely dotted with small blunt whitish papillae,* and also with a few very minute spines. These seem to serve the purpose of holding grains of sand on the body, though they are not actually adhaesive. Had I possessed more material it would have been interesting to make a closer study of the anatomy and segmentation, though careful examination of the single example I have at present mounted seems in most respects to correspond with Schaum's description.

There is no mouth, but the two sickle-like jaws are formed of an upper and lower portion (really mandible and maxilla) easily separated with a needle. Schaum states that these jaws communicate through internal passages with the oesophagus, which is a long tube passing

* These are similar to the "dolichasters" described by Tillyard (in *Psychopsis*) Proc. Linn. Soc. N.S.W., 1918, xliii, Pt. 4, p. 800.

down the extended neck and widening into a crop in the thorax, whence it passes by a more constricted portion into the stomach, which is reniform. He states that there is no posterior opening of the stomach, so that the food must be entirely assimilated. The jaws are suctorial tubes, and doubtless the creature lives entirely on the juices of its prey. There is a small intestine into which open Malpighian tubules.

The head of the insect is of the shape shown in the figure, and bears the eyes, the jaws, a pair of very delicate thread-like antennac, and the two labial palpi, hidden in the drawing by the jaws. The latter act as suctorial fangs. The antennae scarcely described by Schaum are



as shown at *a* in the text-figure. Arising from the small basal part (not shown) there is a long joint, followed by nine to eleven small joints quite distinct under a high power. The number of joints appears to vary in different specimens. The last joint has on it three small setac shown more highly magnified at *b*. One of the palpi is shown at *c*, and my drawing differs slightly though not materially from that of Schaum. The eyes I have not been able to examine critically. Schaum merely states that there are six on either side, but the question of whether they consist of six ocelli, or a compound eye of six facets, must await the acquisition of further material.

The prothorax consists of a somewhat pyriform portion from which extends the characteristic long " neck " which gives the insect so remarkable an appearance. Schaum states, and I think correctly, that the cuticle of the basal part is invaginated at the antcrior end and then extended

to form the neck, so that the latter is merely a hardened extension of the connecting membrane between the prothorax and the head.

According to the author quoted, the shape of the abdomen varies considerably in relation to whether the creature has fasted or had a full meal; in the latter case being convex in front and pointed and coniform posteriorly, while in a starved condition the abdomen becomes flattened and shorter behind. The single example from which my drawing was made had certainly fasted, since I had been unable to induce it to attack any of the small insects from time to time offered to it.

Another live specimen overcame and sucked dry a third example, somewhat smaller than itself, confined in the same tube. It is evident that these larvae can go for long periods without either food or water.

Schaum states that the abdominal segments are nine in number, but it is rather difficult to decide where the abdomen ends and the thorax begins. The legs are all of about the same length, though in the drawing differences will be observed which are due to the foreshortening, as the insect is represented as in the walking position. They are of the same sandy colour as the rest of the insect, though with some darker markings as shown. A peculiar feature of the tarsi, which are unjointed, is that the number of spines thereon is different in each pair. The front tarsi have seven, the middle six, and the hind ones five. At least this is so in the example figured. They terminate in a pair of claws slightly dentate at the extremity. A front tarsus is shown at *c* and a claw more highly magnified at *d*.

The cuticle of the animal is rough and tuberculate. The stigmata are said to number nine, but they are difficult to distinguish without making a preparation of the skin. Schaum gives a small figure of the nervous system, admitting that it is incomplete. I have not had an opportunity to dissect this.

The following note on these larvae has been kindly furnished by Mr. E. N. Willmer.

Note by Mr. E. N. Willmer.

The specimens referred to above were obtained in a desert cave on the east of the Nile, at a distance of about ten miles S.E. of Cairo, and up the valley known as Wadi Digla. In the sides of this wadi there were several caves

which pierced the rock horizontally, and sometimes ended in a deep shaft. The floors and rock ledges of the caves were covered with a very fine dust, which proved to be the home of the larval Nemoptera. Their presence was only made evident by blowing on the sand, and thus causing them to move with their quaint jerky motion. During September they all, with one or two exceptions, appeared to be very small. One imago was obtained flying in the rays of the evening sun as they penetrated into the cave at about 5.30. In August, adults can, I believe, be frequently obtained at about this time of day. It may therefore be supposed that the larvae obtained in September were mostly the offspring of the August imagines. We were unable to ascertain what was the food of the larvae in the natural state; presumably it consists of small mites. The larvae were not confined to the caves, but appeared in smaller numbers on all the shaded ledges, provided these contained the necessary dust. A search in the Pyramids at Gizeh, however, proved fruitless, only serving to mystify the guide. Their absence in this locality was strange, since apparently Nemoptera were first reported from the Pyramids and the same type of dust covers the floors of the passages.

The foregoing description and notes were ready for publication when my friend Mr. C. B. Williams brought from Egypt several further specimens, not merely of the larva but also of the imago, and these were submitted to Mr. C. L. Withycombe, who has made a special study of the Neuroptera. The additional material thus provided seemed to offer the opportunity of a joint paper by that Author and myself, dealing with this species, but examination of the specimens showed that the existing classification of the Crocini (Nemopteridae) was based on mistaken premises. The larva here described is now known to be that of *Pterocroce storeyi*, With. Pending Mr. Withycombe's revision of the species, it was thought desirable therefore to publish the present paper very much in the original form.

Since going to Press the following further note has been received from my friend Mr. C. B. Williams.

The larvae of *Pterocroce storeyi* were first discovered by the late G. Storey, the Entomologist in the Egyptian

Ministry of Agriculture, in a cave in the desert about twelve miles south-east of Cairo, about 1915. He bred a few specimens, which, however, were never identified. Before his death he had told me approximately the position of the cave, but shortly afterwards (in May 1922) Mr. Kirkpatrick and I found them in two other caves in Wady Digla, about four miles from Storey's cave. Later we found them also in this latter.

They are found crawling among the dust and small stones on the floor and ledges of the cave, where they feed presumably on small Dermestid larvae, mites, "silverfish" and other small fry found in these situations.

The general conditions necessary for the Nemopterid larvae seem to be cover from above and absence of wind, allowing the accumulation of the fine dust which they like. Most of the situations are dark, but they have been found near the mouth of the cave in full sunlight.

We have since found them in several other caves and also under deep overhanging ledges, and even in small holes in vertical rock faces.

On the other hand, we searched carefully in the entrance to the excavation in the Pyramids of Giza—where the first recorded Nemopterid larva was found—and failed to discover any.

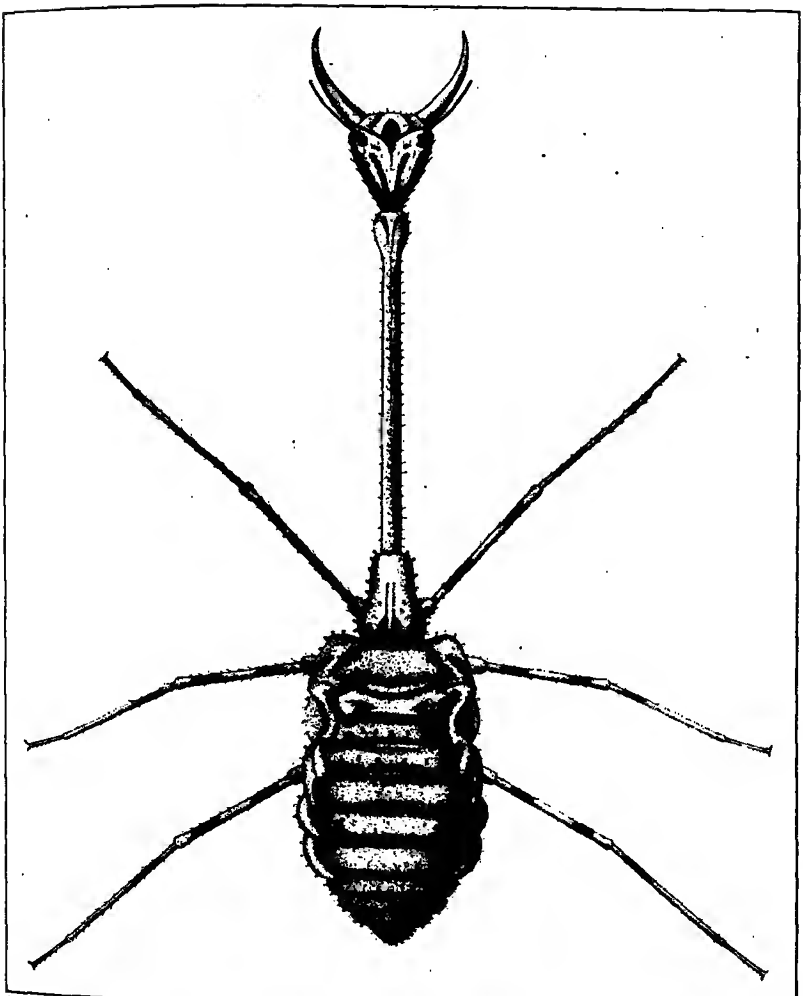
Larvae, both large and small, seem to occur at all times of the year—indicating that more than one year may be spent in the larval stage.

Empty cocoons have also been found in the dust at all times, but the normal pupating season appears to be from May to July.

Adults emerged in July and August, and were seen flying in the caves in Wady Digla in August and September.

They fly about dusk, with an up-and-down, backwards-and-forwards circling movement, the hind-wings spread and hanging down and taking no part in the flapping.

One specimen came into a light-trap in the middle of the Wady.



H. Eltringham del. *Vaus & Crampton.*

LARVA OF PTEROCROCE STOREYI. x 20.

XIII. *Systematic Notes on the Crocini* (Nemopteridae), *with Descriptions of New Genera and Species.* By C. L. Withycombe, M.Sc.

[Read May 2nd, 1923.]

Plates XII, XIII.

Dr. Eltringham has already reviewed the notices of the long-necked Nemopterid larvae similar to those recently exhibited before this Society by Prof. Poulton. For some time opinions have favoured their belonging to the genus *Nemoptera*, but until the present no definite evidence has been forthcoming. It should, however, be stated that Mr. J. Aharoni had bred out the larvae of a Palestine form, though nothing was published upon it at the time. The larva of this was exhibited at the South London Natural History Society in 1920 (1).

Hagen (7) considered that *Necrophilus arenarius* Roux, was probably the larva of *Stenorrhacus costatus* Klug, but no one appears to have entertained the possibility that it could belong to that tribe of delicate Nemopterids, the Crocini of Navás. The possibility of the larva belonging to the Crocini was still further removed by the description of the larva of an Indian species, *Croce filipennis* Westw., by Lefroy (11), Ghosh (5), and more fully by Imms (8). This form was seen to have a comparatively short-necked larva (Plate XII, fig. 1). It may be well imagined, therefore, that my own surprise was great on being shown imagines bred from some of these long-necked larvae by Mr. C. B. Williams, when I observed them to be members of the Crocini.

The credit for first elucidating the life-history of this curious insect belongs to the late Mr. G. Storey, who bred several of these larvae to the imaginal state, and but for his untimely death, would no doubt have published the results of this work. Since this time, several more imagines have been reared by Mr. C. B. Williams, who has very kindly handed over the whole of his material for examination and description. I find that the species

has not previously been described,* and also that it will be necessary to erect a new genus to contain it.

While working upon this species I have had occasion to examine other material of the family Nemopteridae in the British Museum, and I have come upon another new species from Palestine, together with larvae of the same, namely those mentioned above as having been bred by Mr. J. Aharoni.

I am indebted to several friends, who have readily placed material at my disposal and have offered me every facility and assistance. While I can only briefly mention my indebtedness, I would tender my most sincere thanks to Dr. C. J. Gahan and Mr. H. Campion, of the British Museum (Nat. Hist.); to Prof. E. B. Poulton, of Oxford; to Mr. P. Esben-Petersen, of Silkeborg, Denmark; and also especially to Mr. C. B. Williams, who has furnished us with ample material of the Egyptian species. Finally I am much obliged to Mr. H. MacLachlan, through whose kindness I have been allowed to examine several types in the collection of the late Mr. Robert MacLachlan. This has enabled me to detect and rectify some omissions of that excellent entomologist, which omissions, although minor some years ago, have now become significant.

In 1910 (15) Navás monographed the Nemopteridae, and later (17), 1912, he listed the genera and species in Wytsman's Genera Insectorum. These works are regarded at present as standards on the Nemopteridae. Klug (10), Westwood (34), and Hagen (7) had previously monographed the family, but these are too old to be sufficiently comprehensive for present-day students. They are all excellent works for their time, however.

Navás separates the two genera with which we are mainly concerned, as follows:—

Ala anterior con el margen posterior entero, sin escotadura ni vesícula; ala posterior filiforme, sin dilatación . . . . *Croce* McL.

Ala anterior con una escotadura en la mitad del margen posterior, adornada de una vesícula y un

* I am not able to identify this larva with *Necrophilus arenarius* Roux. Roux's figure and description (27) are totally inadequate, and seeing that *Nina chobauti* McL. also occurs in the same locality (Wadi Digla), this might equally well be Roux's *Necrophilus*. The larva of *Nina joppana* sp. n., is also very similar to the present larva, as will be seen.

mechón de pelos; ala posterior del ♂ con dilatación vesicular cerca de su base (al menos en alguna especie) . . . . *Nina* Nav.

This means to say that all examples with fore-wings entire are to be placed as *Croce*; whilst those in which the fore-wings are emarginate posteriorly, and with a "vesicle" or "tuft of hairs" lying in this emargination, also in which the males have a vesicular swelling basally in the hind-wings (at least in some species), are to be placed as *Nina*. This statement is repeated, with some modification, in Genera Insectorum, 1912.

From an examination of the Egyptian material alone it can be seen that such a division as that proposed is artificial. We have three ♂♂ and three ♀♀. The ♂♂ have a "bulla" (= vesicle) in the fore-wings, but no dilatation in the hind-wings. Navás would place them as *Nina*. The ♀♀ have the anterior wings entire and no trace of a "bulla" in either wings. Thus they would be placed in the restricted genus *Croce*, according to Navás' system. Examination of more material at once shows that *all* ♀♀ of the tribe Crocini would be placed as *Croce*, in the same way, while the ♂♂ would go to both genera *Croce* and *Nina*. This state of confusion, even if recognised, stands uncorrected.

In 1913 (20) Navás described *Croce lawi* as a new species from Zambesi. Prof. Poulton has kindly allowed me to examine the type specimen of this in the Oxford Museum. I find that several of the distinguishing characters mentioned by Navás are hardly peculiar to this species and that he has rather inaccurately figured the venation of the wing. For a comparison the base of the wing of Navás' drawing is reproduced in fig. 9, and a camera lucida drawing from the type appears in fig. 10. In 1914 (21) Navás erected a new genus *Laurhervasia* for *Croce lawi* Nav., giving as generic characters those previously mentioned by him for *lawi*.

After examining the type *Laurhervasia lawi* Nav., I am unable to fix upon a single character which will, without exception, separate it from other genera. The specimen is a female, which is unfortunate. It is quite possible, that all the known South African Crocini are congeneric, and consequently the genus *Thysanocroce* which I am proposing for the reception of *damarae* McL., may have to

sink as a synonym of *Laurhervasia* Nav., when this latter genus has been redefined from a knowledge of the male sex. But see postscript, p. 284.

It is now necessary to make an attempt at reconstruction. The tribe Crocini, Navás, comprises all those Nemopteridae which are of small size, and with strongly reduced, filamentous hind-wings. They have been divided by Navás into several genera. Most of these genera are no doubt good ones, but the characters upon which they are separated are almost entirely confined to the male sex. This is unfortunate in many respects, but I have found it extremely difficult to find reliable characters in the female. Until more material has been studied, I fear that no very certain conclusions can be arrived at.

Briefly the genera of Crocini, according to Navás (17), stand as follows, excluding *Laurhervasia* Nav. (21), which was erected later.

"Axillary" vein free and visible in anterior wings	*Josandreva* Nav.
Posterior wings less than double the length of anterior wings	*Klugina* Nav.
Anterior wings entire; no bulla in either pairs of wings	*Croce* McL.
Anterior wings emarginate posteriorly and with a bulla in basal third	*Nina* Nav.

Josandreva appears to me to be a well-defined genus. *Klugina* I have not seen, but the length of the hind-wings does not appear to be a very satisfactory character upon which to erect a genus. *Nina chobauti* McL. also possesses hind-wings less than double the length of the fore-wings, but now that the male is known *chobauti* clearly belongs to the genus *Nina*. I personally consider *Klugina* to be very near, if not actually congeneric with *Croce* restr., from the character of the radius in the fore-wings, which is well shown in Klug's figure (10).

We are now left with the genera *Croce* and *Nina*. It has already been shown that *all* ♀♀ at present fall into *Croce*, and that the genus *Nina* is highly unsatisfactory. From examination of dry material there is reason to believe that a comparison of the male genitalia would prove a valuable guide. This has not been attempted previously. To make a comparison, however, it is necessary to remove and

mount the apex of the male abdomen in balsam. Owing to the scarcity of material I have been unable to do this except for two species, which are now figured, namely *Croce filipennis* Westw. (Plate XIII, fig. 15), and *Pterocroce storeyi* (Plate XIII, fig. 16). With the study of more material, and examination of genitalia one may look forward to a less artificial classification than that which is now proposed, but for the present it is necessary to make the best of what evidence we have. I have diligently searched for reliable characters to be found in both sexes, and with some success, but I recognise the possibility that future work may show some of these to be inconstant; especially as regards the venational details, which in Crocini are frequently variable.

The males of all known genera possess secondary sexual characters of some kind upon the wings. The females, as has been mentioned, always have both fore- and hind-wings unadorned, the hind-wings being very slender. In *Croce* the hind-wing of the male expands a short distance from the base (Plate XIII, fig. 14) and becomes a narrow, flattened ribbon, tapering to the apex. *Nina chobauti* (♂) has a similar expansion, but slightly further out on the wing, and, moreover, it almost immediately tapers again to leave a flat dilatation (Plate XIII, fig. 11). In other species of *Nina* this dilatation forms a definite "bulla" or "vesicle," while in *Thysanocroce* gen. nov. all that represents it is a small tuft of agglutinated hairs (Plate XIII, fig. 12). A "bulla" is also present in the fore-wings of males of the genera *Nina* (Plate XIII, fig. 7) and *Pterocroce* (Plate XII, fig. 5). These "bullae" may possibly be scent organs.

The males of all genera may be tabulated as follows, but with females the matter is not so easy. It is therefore proposed to deal with each genus separately to include both sexes, but not in tabular form, as exceptions in female examples would render such a table unreliable. The system of venational terminology used is that suggested by Comstock (2), but "axillary" vein is a term used by Navás for a somewhat doubtful structure. As the homologies of this vein are uncertain Navás' term has been retained here.

Tribe *CROCINI* Navás.

Table of Genera (♂♂ only).

A. Anterior wing with "axillary" vein visible and not fused with Cu_2 + 1st A for the greater part of its length. Beak short . . *Josandreva* Nav.

AA. Anterior wing with "axillary" vein fused for the greater part of its length with Cu_2 + 1st A, and appearing merely as a "twig" from the latter compound vein.

B. No "bulla" in fore- or hind-wings, but hind-wings slightly flattened, ribbon-like in ♂.

C. Hind-wings less than double the length of fore-wings . . . . . . *Klugina* Nav.

CC. Hind-wings more than double the length of fore-wings . . *Croce* McL. (Plate XIII, fig. 14).

BB. A "bulla" or trace of same in fore, or hind, or in both pairs of wings.

D. A distinct "bulla" in both pairs of wings . *Nina* Nav. (Plate XIII, figs. 7, 11, and 13).

DD. A "bulla" or trace of same only in one pair of wings.

E. A "bulla" in basal third of fore-wings; no trace of "bulla" in hind-wings *Pterocroce* Withyc. (Plate XII, fig. 5).

EE. No trace of a "bulla" in fore-wings, but a vestige in hind-wings, one-third from the base, in the form of a tuft of matted silky hairs. *Thysanocroce* gen. nov. (Plate XIII, fig. 12).

One may now proceed to outline each genus. It would be an advantage to reduce some genera, but I fear that such action would, at the present time, rather increase confusion. Four main groups may be indicated, and it is quite possible that with increase of our knowledge these groups will suffice as genera.

1. *Josandreva* group, comprising *Josandreva* Nav.
2. *Croce* group, comprising *Croce* McL. and *Klugina* Nav.
3. *Thysanocroce* (? *Laurhervasia*) group, comprising *Thysanocroce* gen. nov.
4. *Nina* group, comprising *Pterocroce* Withyc. and *Nina* Nav.

In all probability the Australian species,* of which only

* See footnote on p. 285.

two specimens have been described, *e.g.*, *attenuata* Frogg. and *longipennis* Nav., may form a fifth genus, which could best be placed in the *Nina* group.

The following synopsis of genera is intended to outline the characters applicable to both sexes, but it is especially constructed as an attempt to classify the ♀♀. It has already been shown that the males are easily grouped, mainly on the characters of the hind-wings, but the synopsis below should be of equal value in the determination of both sexes. I would here point out, however, that in the case of those species in which the male has a "bulla" in the fore-wings, the venation of the basal part of the wing in that sex may be affected, and may differ from that of the female even in the region of the origin of the radial sector. In such species the description of venation given here refers mainly to the female. Males should be easily determined by the table already given.

All females are similar in having both fore- and hind-wings simple.

SYNOPSIS OF GENERA OF *CROCINI*.

1. **Josandreva** Navás. Anterior wings with "axillary" vein visible and not fused with Cu_2 + 1st A for part of its length. Hind-wings simple and filiform. Beak short.

Genotype *Josandreva sazi* Navás.

2. **Croce** MacLachlan. Anterior wings (Plate XIII, fig. 8) with radial sector appearing at its origin from R as an oblique cross-vein, whence onwards Rs runs nearly parallel to R. Rs does not fork until it has traversed about half the length of the fore-wing, and before this fork-point at least four cross-veins connect it to media. (All the above characters are very typical of the *Croce* group.) Hind-wings of male (Plate XIII, fig. 14) with a short petiole, then slightly dilating to a flat ribbon and again gradually tapering to the apex. Hind-wings of female simple and filiform. Beak of medium length, about twice the dorsal interocular distance.

The remaining characters may be useful, but will probably be found more liable to vary. Two cross-veins present in field R. Origin of M_{3+4} to Cu_1 about the middle of the long medial field.

Larva with toothed mandibles and a short neck,—less than length of head (Plate XII, fig. 1).

Genotype *Croce filipennis* Westwood.

3. **Klugina** Navás. Anterior wing-venation very similar to that of *Croce*. Hind-wings less than twice the length of fore-wings. Beak apparently of medium length.

Genotype *Klugina aristata* Klug.

4. **Thysanocroce** gen. nov. (Gr. θύσανος, tassel; κρόκη, thread; from the small tuft of hairs upon the hind-wing of ♂.) Anterior wing-venation intermediate between *Croce* and *Nina*. No "bulla" in fore-wings of either sex. In the male the hind-wings have an inconspicuous tuft of matted silky hairs at one-third the distance from base of wing (Plate XIII, fig. 12). Otherwise the hind-wings are simple and filiform in both sexes.

Rs appears more as in *Nina* than in *Croce*. Three cross-veins before origin of Rs; four cross-veins connect stem of Rs to media before the fork-point of Rs. The stem of Rs is about equal in length to one-third of distal branched portion of same. M_{3+4} to Cu_1 at about middle of long medial cell. Hind-wings clothed with fine hairs, except in region of agglutinated hair tufts of male where the hind-wing is less hairy and appears bare (Plate XIII, fig. 12). Beak about two and one-third times the dorsal interocular distance.

Genotype *Thysanocroce damarae* MacLachlan (= *lightfooti* Péringuey). For *Laurhervasia* Navás, see postscript on page 284.

5. **Pterocroce** * Withyc. (Gr. πτερὸν, wing; κρόκη, thread; in allusion to the thread-like hind-wings of both sexes.) Fore-wing venation (Plate XII, figs. 5 and 6) similar to *Nina*. Hind-wings of male with no trace of a "bulla"; hind-wings simple and filiform in both sexes.

Origin of Rs in fore-wings distinct, at first bowed away from R, but then reapproaching it. Two cross-veins in field R. Three cross-veins unite Rs to media before the former forks. Unbranched stem of Rs one-fifth to one-seventh the length of branched portion. Origin of M_{3+4} to Cu_1 at one-third the length of the long medial cell from base of wing, *i.e.* at about the same level as origin of Rs from R. Beak about twice the dorsal interocular distance. Larva with untoothed mandibles and a long "neck," more than three times length of head (Plate XII, figs. 3 and 4).

Genotype *Pterocroce storeyi* Withycombe.

* For preliminary description see Entomologist, 1923, LVI, p. 141.

6. **Nina** Navás. Beak of both sexes longer than in any other genus, viz. about three times the dorsal interocular distance. "Bullae" in both fore- and hind-wings of male, in basal third.

Origin of Rs in fore-wings distinct and bowed slightly away from R at first, but later running nearer to it (Plate XIII, fig. 7). Two cross-veins connect R to M before origin of Rs. Two or three cross-veins unite Rs to M before the former forks. Unbranched stem of Rs about one-sixth the length of branched portion and often even shorter than this. Origin of M_{3+4} to Cu_1 nearly opposite origin of Rs, or at least not further out than the level of the first cross-vein between R_1 and Rs. Hindwings long, simple and filiform, but with a "bulla" in the male (Plate XIII, fig. 13), as mentioned above. Beak very long and gradually tapering, about three times the dorsal interocular distance in length. Larva with a long "neck," more than twice, but less than three times the length of head. Mandibles not toothed (Plate XII, fig. 2).

Genotype *Nina baudii* Griffini.

It is necessary to describe the following new species.

Pterocroce storeyi Withycombe.*

Description of ♂. (Plate XII, fig. 5.)

General colour cream or testaceous, with brownish marking dorsally on the body. In appearance similar to *Pterocroce capillaris* Klug, from which it differs in the venation being of one uniform colour, whereas in *capillaris* the venation is dark variegated with white interruptions.

Head smooth, brownish-white, unmarked, but beak slightly darker at the apex and with some indication of a faint brown mark laterally. Beak twice the dorsal interocular distance. Eyes black. Antennae of the same colour as the head, though slightly more greyish.

Remainder of the body covered with sparse black hairs.

Prothorax about one and a half times as long as broad, testaceous, shaded with pale-brown above. Mesothorax large, and almost spherical. Upon each of the four dorsal sclerites of same a diffuse brownish spot. Metathorax small, twice as broad as long.

Abdomen slender, testaceous. Each tergum with the posterior dorsal half brown. Ventrally the body is white.

Legs slender, greyish-white. Basal joint of tarsus nearly one and a half times the length of terminal joints taken together. Two simple, and almost straight tarsal claws.

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* For preliminary description see Entomologist, 1923, LVI, p. 141.

Anterior wings (Plate XII, fig. 5) with a brown " bulla " in basal fourth, exteriorly to which the posterior margins are strongly ciliated. Veins pale fuscous, all more or less ciliated. Pterostigma, for four or five veins composing it, reddish-brown, whence to the apex of the wing it is whitish. Costal area before pterostigma with ten to twelve cross-veins. R_1 field with nine to eleven cross-veins. In the right wing of type specimen two cross-veins connect the stem of Rs to M before the former forks. The left wing is aberrant.* The stem of Rs is about one-seventh the length of its branched portion. Rs with about nine or ten branches. The long medial cell with six cross-veins, counting the passage of M_{3+4} to Cu_1 as one cross-vein. Three veins run into the posterior margin of the wing before the " bulla." The " bulla " is brown in colour, somewhat oval in general contour, and it does not project to any extent from the outline of the wing.

Hind-wings simple and filamentous, clothed with fine hairs, without any trace of a " bulla." In proximal two-thirds they appear slightly brownish, and the main rachis is brown. The distal third of the hind-wing is white and curled.

Length of body, from vertex to apex of abdomen, 7·5 mm.

Length of anterior wing, 10·3 mm.

Breadth of same, 3 mm. nearly.

Length of posterior wings, 34–35 mm.

Type ♂ in British Museum (Nat. Hist.).

One paratype ♂ in the Oxford Museum, and another paratype ♂ in my collection.

Habitat. The specimens were bred, August 1922, from larvae, taken in small caves in the Wadi Digla, near Cairo, Egypt, by Mr. C. B. Williams.

Description of ♀. (Plate XII, fig. 6.)

Fore- and hind-wings simple, and without " bullae." Colour almost uniformly pale testaceous.

Head smooth, pale brown, slightly suffused with pinkish. Beak twice the dorsal interocular distance—pinkish-brown. Eyes black, antennae greyish, but lighter basad.

Remainder of the body uniformly testaceous, sparsely covered with fine black hairs.

Prothorax slightly more than one and a half times as long as

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* This specimen was selected as type on account of its perfect condition and coloration. The two paratypes have the markings, faint as they are, obscured by a reddish suffusion, due to the decomposition of fatty material within the body.

broad. Mesothorax large and subspherical. Metathorax smaller, transverse. Abdomen fusiform in this dried specimen. Legs slender, greyish-white; first tarsal joint longer than the other tarsal joints taken together.

Anterior wings (Plate XII, fig. 6) with uniformly pale-brown veins, sparsely ciliate. Pterostigma red-brown. Posterior margin strongly fringed with fine, colourless hairs. Costal field with ten or eleven cross-veins before pterostigma. Pterostigma with four distinctly red-brown veins, then becoming paler to the apex. Nine cross-veins in R_1 field. Three cross-veins connect stem of Rs to M before Rs forks. Stem of Rs about one-sixth the total length of Rs. Rs seven- to eight-branched. Six cross-veins in long medial field, counting origin of M_{3+4} as one cross-vein.

Hind-wings three times the length of anterior wings, filamentous and simple, somewhat greyish-brown, but becoming white distally.

Length of body, excluding beak, 7 mm.

Length of anterior wing, 11 mm.

Breadth of anterior wing, 3·1 mm.

Length of posterior wing, 33 mm.

Type ♀ in British Museum (Nat. Hist.).

One paratype ♀ in the Oxford Museum, another in my collection.

Habitat. Wadi Digla, near Cairo, Egypt, August 1922. Bred from larvae by Mr. C. B. Williams.

Description of Full-fed Larva. (Plate XI and Plate XII, figs. 3 and 4.)

Body ovoid, mainly creamy-white in colour. Head small, triangular, borne at the extremity of a long "neck." Legs long and slender. Entire body surface sparsely covered with short macrotrichia modified as "dolichasters."

Head rather triangular, whitish in colour, but more or less patterned with fuscous. This pattern may be very distinct or almost absent. It is always darkest posteriorly both above and below. (Dr. Eltringham's drawing shows a fairly typical larva, my figures 3 and 4 show two extremes.) Jaws long and rather slender, inwardly curved. They are longer than the head. Mandibles not toothed. The jaws are whitish basally, but become fuscous for the greater part of their apical length. Eyes placed well forward, laterally, near the bases of the jaws. Antennae about two-thirds the length of the jaws, very slender, and eleven- to thirteen-jointed. The basal joint is stout, about twice as long as broad, constricted slightly at its middle. The second joint is

slender and of the same width as the remaining nine to eleven joints, but in length it is almost equal to the remaining joints taken together. The distal eight or nine joints are of approximately equal length. Labial palpi short. The basal segment is enlarged, the two terminal joints being slender.

"Neck" more than three times the length of the head and sometimes nearly four times the same. It is dilated anteriorly and here usually ringed incompletely with fuscous. For the remainder of its length it is of uniform thickness. As also the rest of the body, the "neck" is clothed sparsely with papillae bearing macrotrichia in the form of lanceolate spines or dolichasters. The next, or middle portion of the prothorax is about the same length as the head. It is dilated posteriorly and bears the first pair of legs below. It is more or less pigmented with fuscous, especially posteriorly. The hind portion of prothorax is compressed antero-posteriorly. It is often marked with fuscous, especially at the spiracles.

Rest of thorax appearing as part of the body proper, this whole being of oval shape, and somewhat flattened dorso-ventrally. The body is of a creamy-white colour, generally marked with some fuscous. There are three more or less distinct transverse bands, and other fuscous markings in the middle line, in well-marked examples. The abdomen is of ten segments, but only eight are visible, the last two segments being completely retracted.

Legs long and slender; whitish banded with fuscous. The coxae and trochanters are mainly white. The femora are conspicuously banded, there being to each a fuscous band near the base, and another just above the knee. The knee itself is white. Tibia and tarsus fairly uniformly pale fuscous. Tarsus one-jointed, with two almost straight tarsal claws, simple except for one obscure tooth near the apex of each.

Length of entire larva, about 1 cm.

Length of "neck" alone, 2·7 mm.

Length of head, ·8 mm.

Habitat. In sandy caves, Wadi Digla, Cairo, Egypt.

For further structural details I would refer to Dr. Eltringham's paper and to his drawings.

One other specimen of Mr. C. B. Williams' material remains to be noticed. This is a well-marked female of *Nina chobauti* McL. Attached to it is the label "Wadi Digla, Egypt, 29/5/22, taken at light." It may be mentioned that the pterostigma is wholly of an opaque white in this specimen.

Nina joppana sp. n.

Description of ♂. (Plate XIII, figs. 7 and 13.)

General colour greyish-white, not appreciably marked. A small, though typical *Nina*. It differs from previously described species of *Nina* in its slender build, in the absence of definite markings, and in the nature of the secondary sexual characters of the male.

Head smooth, greyish-white, without markings. Beak more than twice ($2\frac{1}{2}$) the dorsal interocular distance, slightly darker than the head, and brownish laterally. Antennae about twice the length of the beak, filiform, but slightly expanding distally. Colour grey, basal joints whiter, and terminal portion almost black. Eyes black.

Prothorax longer than broad, greyish above, lighter ventrally. Mesothorax large and almost spherical, fuscous dorsally. Metathorax small, and somewhat lighter in colour. Below, the thorax is white.

Abdomen with each segment of lighter colour in front, and posteriorly shaded with fuscous; thus the abdomen is obscurely annulated. Ventral surface paler.

Legs greyish-white, tarsus five-jointed, with the first joint slightly longer than the remaining four joints taken together. The two tarsal claws are simple and almost straight.

Anterior wings (Plate XIII, fig. 7) with the costal margin straight as far as pterostigma, whence to the tip it is rounded. Posterior margin strongly ciliated with long hairs, and with a white, somewhat acutely triangular "bulla" projecting at about two-fifths the length of the wing from the base. Venation uniformly greyish, except pterostigma, which consists of about four pale-brown cross-veins in the costal margin near the apex. All veins more or less ciliate. In costal field thirteen cross-veins before pterostigma. R_1 field with sixteen cross-veins. Three cross-veins connect Rs with M before the fork-point of Rs. Stem of Rs before forking about one-seventh the length of branched portion of same. Rs with nine to ten branches. Long medial field with nine cross-veins, counting the passage of M_{3+4} to Cu_1 as one cross-vein. Seven to eight veins run into the inner margin of the wing before the "bulla." The latter is silky white, flattened and pointed, and projects from a slight indentation of the inner margin.

Hind-wings filamentous, about three times the length of the fore-wings. They are finely pubescent, white, though somewhat greyish proximally. At one-seventh their length from the base is a blackish "bulla" (Plate XIII, fig. 13).

Length of body, excluding beak, 6·3 mm.
Length of anterior wing, 10·5 mm.
Breadth of same, 3 mm.
Length of posterior wing, 32 mm.

Type ♂ in British Museum (Nat. Hist.).

Habitat. The types ♂ and ♀ were bred from larvae taken by Mr. J. Aharoni, in caves at Rehoboth, near Jaffa, Palestine, in 1921.

NOTE.—The left wing of the type specimen is damaged. Where the venation has been interfered with, the description above refers to the right wing.

Description of ♀.

As in ♂, general colour greyish-white, but both fore- and hind-wings simple.

Head whitish, not appreciably marked. Beak slightly fuscous, and decidedly brown in apical third; two and a half times the dorsal interocular distance. Antennae incomplete. The basal joints are white, the few remaining joints greyish.

Body shaded with pale fuscous above, below it is whiter. The abdomen is less noticeably annulated than in the male.

Legs greyish-white, tarsus with basal joint slightly longer than the remaining joints taken together.

Anterior wings entire, without "bulla." Venation almost uniformly greyish. All veins more or less ciliated. Inner margin fringed with longer hairs. Costal field with thirteen to fourteen cross-veins before pterostigma. Pterostigma brown, contained within about five costal veinlets, shading distally to opaque white. Stem of Rs about one-eighth the length of branched portion of same. Two cross-veins connect Rs, before its fork point, to M, but this specimen appears to be a variant. Fourteen to sixteen cross-veins in R_1 field. Rs eight- to ten-branched. Seven to nine cross-veins in the long medial field.

Hind-wings simple and filamentous, finely ciliate, about two and a half times the length of the fore-wings. Colour white, slightly greyish proximally.

Length of body, excluding beak, 7 mm.
Length of anterior wing, 12 mm.
Breadth of same, 3·2 mm.
Length of posterior wing, about 30 mm.

Type ♀ in British Museum (Nat. Hist.).

Habitat. As ♂, Rehoboth, near Jaffa, Palestine, bred from larvae by Mr. J. Aharoni, 1921.

NOTE.—The right wing of type is slightly damaged.

Description of Full-fed Larva. (Plate XII, fig. 2.)

Very like the larva of *Pterocroce storeyi*, but "neck" shorter.

Body ovoid, creamy-white in colour. Head triangular, borne upon a long "neck." Legs long and slender. Body surface covered sparsely with "dolichasters."

Head somewhat triangular, whitish, but largely suffused with fuscous, especially posteriorly. In the five larvae examined the head pattern is constant, and is very similar to that of a dark example of *P. storeyi*. Jaws slender and tapering, caliper-like, yellowish in colour, but becoming more brown apically. Mandibles not toothed. Eyes placed laterally near the bases of the jaws, each eye consisting apparently of six ocelli. Antennae very slender, dark fuscous, and about two-thirds the length of the jaws. Each antenna consists of a fairly stout basal joint, twice as long as broad, constricted slightly at its middle. The second joint is slender and constitutes about one-half the flagellum. Beyond this are ten almost equal joints. Labial palpi consist each of a broad basal segment, which is possibly the palpiger, and a short, two-jointed palpus proper of darker fuscous colour. At the base of each maxilla, and lying near the labial palpus, are two triangular sclerites, which probably represent stipes and cardo of the maxilla.

"Neck" not so long as in *Pterocroce storeyi*, less than three times the length of the head. The dilated anterior portion is ringed with dark fuscous, but the rest of the "neck" is pale whitish in colour. Middle division of prothorax about the same length as the head, of whitish colour shaded with fuscous, especially posteriorly, where it is dilated. The first pair of legs is attached ventrally to this portion of the prothorax. The third division of the prothorax is whitish, except for a dark brown spot on each side in the neighbourhood of the spiracles.

Rest of body flattened and oval, appearing as one whole, creamy-white in colour and not appreciably marked with fuscous. As before, there are truly ten abdominal segments, but only seven or eight are normally visible.

Legs long and slender, femora conspicuously twice banded with fuscous. The coxae are well-developed and rather elongate, pale in colour. The femora are whitish, with a broad band of fuscous at their bases, and another just above the knees. Tibiae pale fuscous. Tarsi unjointed, with two tarsal claws and no apparent empodium. Each tarsal claw is obscurely toothed just before the apex.

Length of entire larva, 8–9 mm.

Length of head, ·83 mm.

Length of "neck" alone, 2·28 mm.

Habitat. In small caves, Rehoboth, near Jaffa, Palestine, 1921. Taken by J. Aharoni.

As regards the new genus *Thysanocroce*, which I propose to receive *Croce damarae* McL., this may be distinguished from any other existing genus by the fact that in the male there is no "bulla" in the fore-wings, but in the hind-wings there is a small tuft of matted, silky hairs (Plate XIII, fig. 12).

In 1909 (24) Péringuey described *Croce lightfooti* from the Cape and Damaraland, and remarked that it differed from *C. damarae* McL. in possessing a tuft of lanuginose silky hairs in the hind-wings, and also in having all the veins of the fore-wings hairy. Through the kindness of Mr. Hugh MacLachlan I have been able to examine the type of *damarae* McL., and I find that both the distinguishing characters mentioned by Péringuey are present in MacLachlan's type. It is highly remarkable that such a careful worker as MacLachlan should have overlooked the hind-wing character, though it is certainly very small. It is therefore now necessary to place *lightfooti* Pér., as a synonym of *damarae* McL.

The only other species likely to belong to the genus *Thysanocroce* is *setacea* Klug, which also is recorded from South Africa.

POSTSCRIPT: The genus *Laurhervasia* Nav., differs from *Thysanocroce*, and also from the majority of other genera, in that R_1 field is completely filled with cross-veins, it being more usual for the distal portion of this to be devoid of such cross-veins. Thus the two genera *Laurhervasia* and *Thysanocroce* are probably distinct.

The present species appear to me to fall into the following genera. The arrangement is given as purely provisional, since in many cases I have not seen examples of the species in question, and descriptions are frequently inadequate. The majority of the species marked "?" appear to me to be females.

1. Genus *Josandreva* Nav. (14).
   sazi Nav. (14).
2. Genus *Klugina* Nav. (15).
   aristata Klug (10).
3. Genus *Croce* McL. (12).
   filipennis Westw. (33).
   braueri Nav. (15).

4. Genus *Laurhervasia* Nav. (21).
lawi Nav. (20).

5. Genus *Thysanocroce* gen. nov.
damarae (13) McL. (= *lightfooti* Pér. (24)).
? *setacea* Klug (10).

6. Genus ? *
attenuata Frogg. (3).
longipennis Nav. (15).

7. Genus *Pterocroce* Withyc.
storeyi Withyc.
capillaris Klug (10).

8. Genus *Nina* Nav. (15).
baudii Griff. (6).
meade-waldoi Nav. (16).
chobauti McL. (13) (= *harterti* Nav., teste Esben-Petersen (25)).
leptostoma Nav. (vide 17).
? *necrosia* Nav. (18).
? *ephemera* Gerst. (4).
? *pusilla* Tasch. (30).
? *alba* Oliv. (22).

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* Since writing this paper I have seen a specimen in the British Museum (Nat. Hist.) which appears to be the male of *longipennis* Nav., the latter being a female. Both fore- and hind-wings of the male are simple. The hind-wing is long and thread-like as in the female (*longipennis* type), but it is much more strongly pubescent. The characters of this specimen certainly support my suggestion of a distinct genus for the Australian species, but I await the acquisition of more material before attempting to define such a genus. Both the Australian specimens appear to be most nearly allied to *Pterocroce* venationally, but there is no trace of a "bulla" in the fore-wing of ♂.

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21. NAVÁS (1914). Mem. Ac. Barcelona, x, No. 30, p. 23.
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23. PACKARD (1898). "A Text-Book of Entomology," p. 42.
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25. ESBEN-PETERSEN (1920). Archiv. f. Naturg., lxxxiv (1918), Abt. A, 9 Heft, p. 152.
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28. SCHAUM (1857). Berliner Ent. Zeitschr., i, pp. 1–9.
29. SHARP (1895). Cambridge Natural History, Insecta, Pt. I, p. 462.
30. TASCHENBERG (1883). Zeitschr. f. Naturw., lvi, Ser. 4, ii, p. 183.
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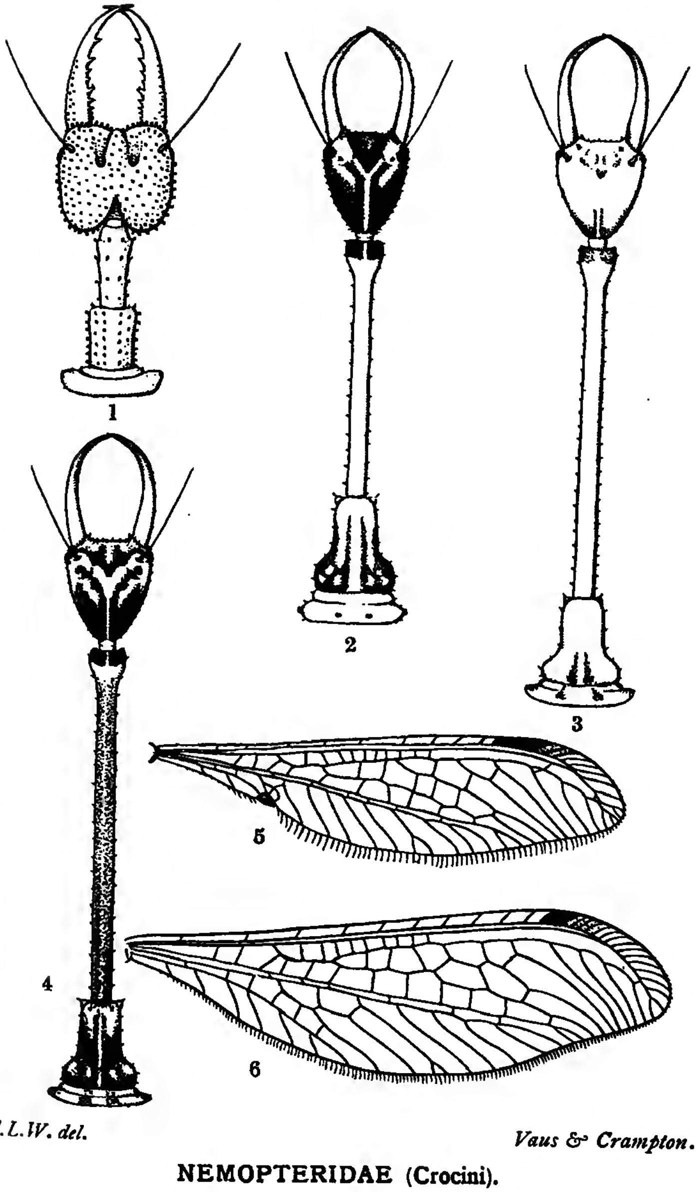
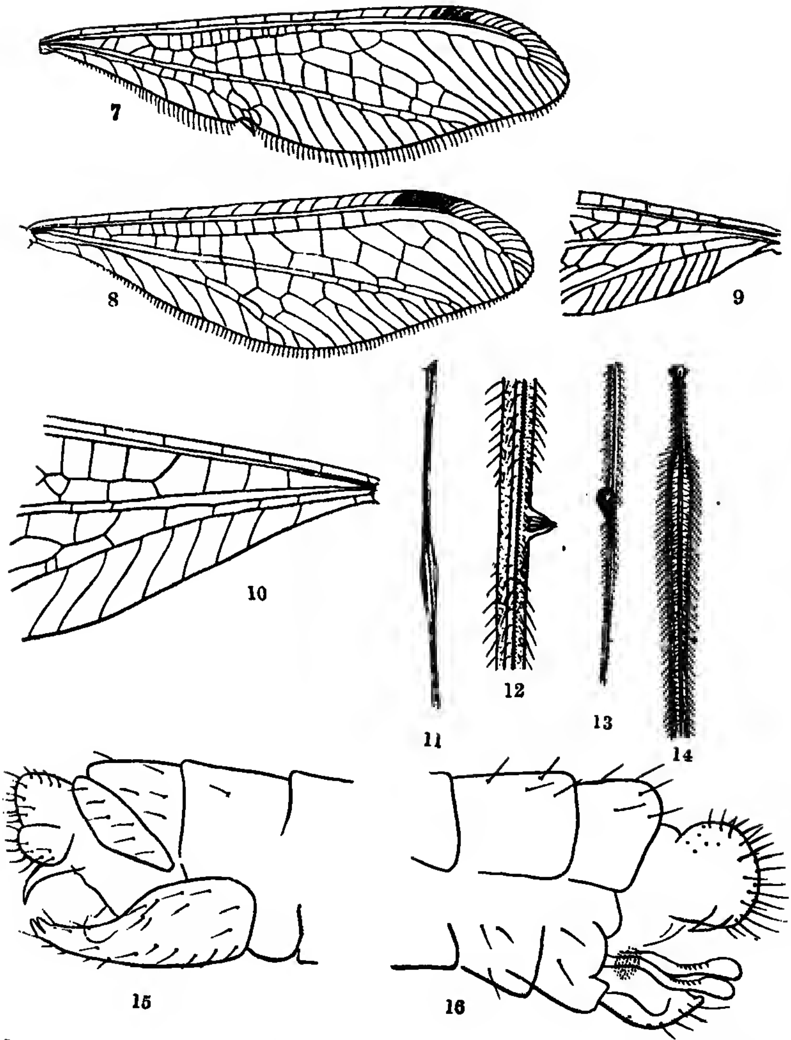


C.L.W. del.

Vaus & Crampton.

NEMOPTERIDAE (Crocini).



C.L.W. del.

Vaus & Crampton

NEMOPTERIDAE (Crocini).

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Explanation of Plates XII and XIII.

Fig.

1. Head and prothorax of *Croce filipennis* Westw., larva full-fed.
2. ,, ,, ,, *Nina joppana* sp. n. ,, ,,
3. ,, ,, ,, *Pterocroce storeyi* sp. n. ,, ,, (light form).
4. ,, ,, ,, ,, ,, ,, ,, (dark form).
5. Right fore-wing of *Pterocroce storeyi* sp. n., ♂ paratype.
6. ,, ,, ,, ,, ♀ type.
7. ,, ,, *Nina joppana* sp. n., ♂ type.
8. ,, ,, *Croce filipennis* Westw., ♂.
9. Base of left fore-wing of *Laurhervasia lawi* Nav., after Navás.
10. ,, ,, ,, ,, ,, ,, camera lucida drawing from type.
11. ,, right hind-wing of *Nina chobauti* McL., ♂.
12. Portion of left ,, *Thysanocroce damarae* McL., type ♂ (from a rough pencil sketch, more enlarged than figs. 11, 13 and 14).
13. Base of right ,, *Nina joppana* sp. n., type ♂.
14. ,, ,, ,, *Croce filipennis* Westw., ♂.
15. Male genitalia of *Croce filipennis* Westw.
16. ,, ,, *Pterocroce storeyi* Withyc., paratype.

XIV. *On the* Mallophaga *of the Shackleton–Rowett Expedition*, 1921–1922. By JAMES WATERSTON, B.D., D.Sc.

[Read May 2nd, 1923.]

AT two points during the recent voyage of the "Quest" —St. Vincent (Cape Verde Is.) and St. Paul's Rocks—some examples of the above Order were collected by Capt. G. H. Wilkins. From the first locality an Owl was examined and from the second an Albatross. At St. Paul's Rocks also, Mallophaga were taken from the material of a Noddy's nest which was touching that of a Gannet. In the tube so labelled two parasites—one from each host—were mixed, and Capt. Wilkins correctly noted that he had seen one of the Noddy's nest parasites on the Gannet also. This mingling of parasites from different hosts, under natural conditions, is a somewhat uncommon and interesting phenomenon. It has been previously noted in the Galapagos Islands by Kellogg and Kuwana, who point out as its cause the enforced crowding together on a restricted land surface of hosts which have normally separate habitats.

In Capt. Wilkins' material—44 examples—the following five genera and species are represented.

MALLOPHAGA.

I. *AMBLYCERA.*

Family MENOPONIDAE Mjöberg.

Genus **COLPOCEPHALUM** Nitzsch.

Colpocephalum milleri Kell. and Kuw.

Colpocephalum milleri Kellogg and Kuwana. Proc. Wash. Acad. Sci., vol. iv, p. 483, Pl. XXX, fig. 6 (Sept. 1902).

3 ♀. *Sula leucogaster* and *Anous stolidus* (nest). St. Paul's Rocks, 8. xi. 1921.

The Noddy (*Anous*) is the true host. Originally described from this bird, and at the same time recorded from such diverse genera as *Butorides*, *Camarhynchus* and *Geospiza*.

I have to thank my friend Prof. G. F. Ferris, Stanford University, California, for confirming this identification by comparison with the type.

II. *ISCHNOCERA.*

Family PHILOPTERIDAE Burmeister.

Genus **PHILOPTERUS** Nitzsch.

Philopterus rostratus Burm.

Philopterus rostratus Burmeister. Handbuch der Entomologie, Bd. 2, p. 427 (1838).

3 ♂, 13 ♀, 8 imm. *Tyto alba detorta.* Cape Verde Is. St. Vincent, 28. x. 1921.

Genus **ESTHIOPTERUM** Harrison.

Esthiopterum concinnum Kell. and Chap.

Lipeurus concinnus Kellogg and Chapman. New Mallophaga, iii, p. 97, Pl. VII, fig. 2 (28. ii. 1899).

♀. *Diomedea exulans.* St. Paul's Rocks, 8. xi. 1921.

Confirmed by Prof. G. F. Ferris by comparison with the type.

Genus **PECTINOPYGUS** Mjöberg.

Pectinopygus sulae Rud.

Lipeurus sulae Rudow. Zeitschr. für ges. Nat., xxxvi, p. 134 (1870).

Lipeurus helleri Kellogg and Kuwana. Proc. Wash. Acad. Sci., iv, p. 479, Pl. XXX, fig. 3 (1902).

4 ♀. *Sula leucogaster* and *Anous stolidus* (nest). St. Paul's Rocks, 8. ix. 1921.

The Sula is the real host.

Though more than one Esthiopterine species has been recorded from *Sula leucogaster,* I feel fairly confident in employing Rudow's *sulae* for these specimens. They seemed also to correspond well with the description and figure of *L. helleri,* an opinion confirmed by Prof. Ferris by comparison of one with the type.

The characters on which *Pectinopygus* Mjöb. is founded are largely specific, and if over-emphasised would restrict the genus to *P. bassanae* O. Fab., the well-known parasite of *Sula bassana* Linn. The Esthiopterines of Gannets, however, form a somewhat compact group to which *Pectinopygus* may conveniently be applied.

Genus **DOCOPHOROIDES** Giglioli.

Docophoroides brevis Duf.

Philopterus brevis Dufour. Ann. Soc. Ent. France, iv, p. 676, Pl. 21, fig. 3 (1834).

3 ♂, 4 ♀, 5 imm. *Diomedea exulans*. St. Paul's Rocks, 8. xi. 1921.

This—the Wandering Albatross—is the normal host of *D. brevis*.

Lists of Hosts and Parasites.

Tyto alba detorta Hart.

Philopterus rostratus.

Anous stolidus Linn.

Colpocephalum milleri.

and

Sula leucogaster Bodd.

Pectinopygus sulae.

Diomedea exulans Linn.

Esthiopterum concinnum.
Docophoroides brevis.

British Museum (Natural History), Nov. 1922.

August 10th, 1923.

XV. *Scent-organs in the Genus* Hydroptila (Trichoptera).

By Martin E. Mosely, F.E.S.

[Read October 3rd, 1923.]

Plates XIV, XV and Two Text-figures.

On October 15th, 1919, a paper was read before the Society giving particulars of eversible filaments and other forms of scent-organ occurring in the British species of *Hydroptila*. Since then two new British species have been described, and Mr. K. J. Morton very kindly gave me two examples of *H. pulchricornis* from his collection. In an abundant collection of Trichoptera from America, it was possible to ascertain that scent-organs were present in all the *Hydroptila* species that were represented.

Sufficient material has now been examined to make it desirable that a second paper on the subject should be published. Unfortunately the American examples had been preserved in various forms of alcohol, and were many years old when received, and, although there were several hundred individuals, in not a single instance were the scent-filaments displayed, and the alcohol had rendered the specimens so hard and brittle that it was found impossible to obtain sections. The condition of the specimens rendered the task of dissecting out the organs more than usually precarious.

It should be noted that when collecting these insects with a view to obtaining examples with the scent-organs everted, it is desirable to employ a fluid containing a few crystals of menthol in complete solution. A carefully filtered collecting fluid should be used consisting of 2 parts of a 2% solution of formalin to 1 part of alcohol (any percentage) saturated with menthol which is only slightly soluble in the mixture. It is of the utmost importance that no menthol should remain undissolved in the form of an oil floating on the top of the fluid. For sectioning purposes a mercury fixing solution is desirable, if not essential, and it is perhaps of advantage that the scent-organs be not everted. Specimens in the formalin-alcohol-menthol fluid should be transferred after an hour or so to a 2% solution

of formalin in which they may be preserved indefinitely. In my own collection there are several thousand Trichoptera, etc., so preserved, collected more than fifteen years ago, and no difficulty is ever experienced when it becomes necessary to clear a specimen for a balsam preparation.

Description of Scent-organs.

Hydroptila cornuta Mosely. (Figs. 1 and 2.)

In this species there appear to be no filaments. The scent-organ is very obscure and seems to consist merely of two groups of scent-hairs arising from membranes which line the inner surface of each of the two lobes or scent-organ covers.

Figs. 1 and 2 were kindly drawn from my sketches, by

Fig. 1.

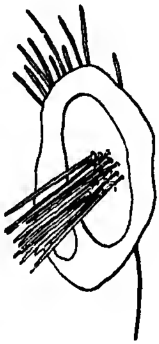

Fig. 2.

Dr. Harry Eltringham, M.A., whose views as to the scent-organ after examining the preparations, coincided with mine.

Hydroptila angulata Mosely.

The scent-organ so closely resembles that of *H. simulans* that a special figure is unnecessary. It is only by microscopical investigation with a high-power objective that the scent-hairs of the eversible brushes, two in number, are seen to be of much finer texture than those of *simulans* and destitute of tho external structure that has been observed in this species.

Hydroptila pulchricornis Pict.

As mentioned above, Mr. Morton kindly gave me two examples his species, enabling me to make a thorough examination of the

scent-organ. The lobes are similar in shape to those of *femoralis*, but do not carry any androconia. The hairs of the two eversible scent brushes are dark grey, much finer than in *femoralis*, and are not so much broadened at the extremities.

These three species are all British; I am indebted to Mr. J. T. Lloyd for the American material which has enabled me to describe the scent-organs in the following species.

Hydroptila consimilis Morton. (Plate XIV, fig. 1.)

The lobes of the head are bell-shaped. Through the mouth of each bell a filament can be everted densely clothed with rather broad hairs. Tufts of hairs arise from the membrane at the base of each lobe. No androconia have been observed.

Hydroptila hamata Morton. (Plate XIV, fig. 2.)

In this species, the scent-organ closely resembles that of the European species *pulchricornis*. The lobes are acorn-shaped, perhaps in this respect more resembling those of *simulans*. There are two eversible filaments clothed with black hairs, which are scarcely broadened at the extremities. No androconia have been observed.

Hydroptila perplexa Mosely. (Plate XIV, fig. 3.)

This species very closely resembles *hamata* in respect to the genitalia, but differs considerably in the construction of the scent-organ. The lobes are less elongated and the lining membranes carry rather narrow, pointed androconia. The two eversible filaments are densely clothed with golden yellow hairs. In the figure these hairs appear dark, as it was found necessary to stain them in order to obtain a photograph.

Hydroptila perdita Morton. (Plate XV, fig. 4.)

The lobes are long, rather narrow, apparently cylindrical with the apices truncate. The two eversible filaments, clothed with yellowish hairs are everted through the apices of the lobes. No androconia have been observed.

Hydroptila delineata Morton. (Plate XV, figs. 5 and 6.)

The lobes are short and broad as in *sparsa* and there appear to be no eversible filaments. On membranes lining the inner side of each

lobe are massed great numbers of hairs which are immensely broadened towards the extremities. This broadening begins midway up the hair, the root of the hair dwindling to a very fine point, giving it a tadpole appearance. The hairs carry a very elaborate structure, as shown in fig. 6.

Explanation of Plates.

PLATE XIV.

Fig. 1. *Hydroptila consimilis.*
2. ,, *hamata.*
3. ,, *perplexa,* one lobe removed to show scent-brush.

PLATE XV.

Fig. 4. *Hydroptila perdita.*
5. ,, *delineata.*
6. ,, ,, a scent-hair greatly magnified, the tapering point not shown to its full length.

Photo by M.E.M. *Vaus & Crampton*

SCENT ORGANS OF HYDROPTILA

Fig. 4

Fig. 5

Fig. 6

Photo by M.E.M. *Vaus & Crampton*

SCENT ORGANS OF HYDROPTILA

XVI. *Coleoptera from the Seychelles: Lampyridae, Helodidae, Cantharidae, Melyridae, and supplement to Cleridae.* By G. C. Champion, F.Z.S.

[Read October 3rd, 1923.]

At Dr. Hugh Scott's request I have named or described a few Malacoderm-beetles obtained by him in the Seychelles, forming part of the collections made by the Percy Sladen Trust Expedition of 1908. The ten species enumerated represent four Families [the supplement to Cleridae is excluded from this reckoning], the Helodidae alone being at all numerous. In addition to these, one genus, of which a single fragmentary example was captured in Silhouette, seems to be related to *Carphurus* Er.; but as this insect has the tarsi slender and simple, it cannot be referred to that genus. An imperfect *Cyphon* and an immature *Scirtes* (both from Mahé) must also remain undetermined for the present. The total number of representatives of these Families obtained in the islands is therefore thirteen: only two appear to have been previously recorded, *Luciola laeta*, and a form doubtfully referred to *Melyris* (see Kolbe, Mitt. Zool. Mus. Berlin, v, 1910, p. 24). The fragile Helodidae are not likely to be carried by commerce, and they must be treated as endemic, a conclusion which is supported by the fact that all the material of this Family was found in the endemic forests in the mountains.* A first set of the material, including the *types* of the new species, will be placed in the British Museum, and a second set in the Cambridge University Museum.†

* [To the list of species occurring between the leaf-bases of palms must be added the undetermined species of *Cyphon*: see p. 298, footnote.—H.S.]

† Two corrections to my paper on a portion of the Heteromera of the same Islands [Ann. and Mag. Nat. Hist. (8) xix, pp. 161–187, Feb. 1917] may be noticed here: *Oxacis lineola* Fairm. (pp. 169, 170) should be quoted *O. striola* Fairm.; *Mordella peregrinator* Champ. = *M. tricolor* Wiedem. Mr. Andrewes has been kind enough to compare one of the specimens named by me with the type of the latter in the Copenhagen Museum. I failed to identify it from the description.

List of Species.

Lampyridae.

1. *Luciola laeta* Gerst.

Helodidae.

2. *Cyphon insularius*, sp. n.
3. „ *circumductus*, sp. n.
4. „ *mahensis*, sp. n.
5. „ *biperforatus*, sp. n.
6. *Scirtes seychellensis*, sp. n.
7. *Ptilodactyla scabrosa*, sp. n.

Cantharidae (= Telephoridae).

8. *Caccodes debilis* Sharp.

Melyridae.

9. *Laius sericatus*, sp. n.
10. *Xamerpus* (?) *cioides*, sp. n.

Cleridae [Supplement]

11. *Allochotes praslinensis*, sp. n.

Lampyridae.

1. Luciola laeta, Gerst.

Luciola laeta Gerstaecker, Arch. f. Naturg. xxxvii, 1, p. 55 (1871); Kolbe, Mitt. Zool. Mus. Berlin, v, p. 23 (1910).
Luciola transversicollis Fairmaire, Ann. Soc. Ent. Fr. 1884, p. 233, and Bull. Soc. Ent. Fr., 1891, p. xlvi; Alluaud, Bull. Soc. Ent. Fr. 1898, p. 99.

Loc. Seychelles: Mahé. Originally described from Mombasa and also recorded from Madagascar and the Comoros.

This species seemed to be somewhat local in its distribution in Mahé. Five examples were taken near Morne Blanc, at about 800 feet, where the insect appeared in numbers on many evenings in October and November, 1908, and eight specimens were captured at the Mare aux Cochons, at about 1500 feet elevation, where numbers were seen on more than one evening between 26. i. and 2. ii. 1909.* Apart from these two localities, this species was not met with by Dr. Scott. It was taken at Mamelles Plantation by Brauer (see Kolbe, *l.c.*). The other references cited above contain no mention of any particular part of the island. Two examples were obtained in Mahé by Gardiner in 1905, and there is one in the Cambridge Museum taken in the same island at light, 6. i. 1888.

Helodidae.

2. Cyphon insularius, sp. n.

Rather convex, shining, thickly clothed with pallid pubescence; varying in colour from obscure testaceous to almost wholly black

* See H. Scott, Tr. Linn. Soc. London, ser. 2 (Zool.), xiv, pp. 29, 33 (1910).

(the labrum excepted), the form selected as typical having the head, prothorax, and scutellum nigro-piceous, and the elytra obscure testaceous, with the sides and apex darker; the legs and antennae testaceous; the entire upper surface closely, strongly punctured, the puncturing of the elytra a little coarser and more diffuse than that of the prothorax. Head very broad, the eyes large; antennae long, slender, joint 3 very small. Prothorax short, broad. Elytra narrowing from about the middle, slightly flattened behind the scutellum, without sexual mark of distinction.

Var.? Larger, ferruginous, the elytra less rounded at the sides; the head more coarsely punctured. [Mahé.]

Length $1\frac{4}{5}$–$2\frac{1}{2}$ mm.

Loc. SEYCHELLES: Silhouette, Mahé. Silhouette; 16 examples from the marshy plateau of Mare aux Cochons, over 1000 feet, or from the endemic forest above, viii.–ix. 1908. Mahé: Mare aux Cochons district, 1000–2000 feet; Cascade Estate, about 1000 feet; slopes of Morne Seychellois, about 1500–2000 feet; 7 specimens altogether, including two of the variety, all i.–ii. 1909.

A long series (21 examples of the typical form and 2 of the variety) from Silhouette and a few from Mahé, apparently belonging to one variable species. A small convex form, with the entire upper surface closely, strongly punctured, the head and prothorax very broad. No sexual marks of distinction are visible, but the presumed ♂♂ have longer antennae than some of the other specimens. The form selected as typical, from Silhouette, with the head and prothorax almost black, and the elytra in great part testaceous, is characteristic. The two unicolorous reddish specimens with a more coarsely punctured head may not be conspecific with the rest.

3. **Cyphon circumductus**, sp. n.

Somewhat depressed, rather broad, oblong, shining, closely pubescent; rufo-piceous, the front of the head, antennae, legs, and a very large, broad, common, cordiform space on the elytra (extending from the base to about the apical third and reaching the humeral callus) testaceous, the rest of the elytra nigro-piceous, the dark apical portion gradually narrowing forwards and reaching the shoulder; the head and elytra closely and rather strongly, the prothorax more finely, punctured. Head broad, the eyes large; antennae long, slender. Prothorax very short. Elytra much wider than the

prothorax, subparallel, the humeri rounded, the apices broadly conjointly rounded.

Length 2 mm.

Loc. SEYCHELLES : Mahé; country above Port Glaud, about 500–1000 feet, 5. xi. 1908.

One specimen, showing no sexual mark of distinction. A rather broad, small, oblong form, with the elytra subparallel and peculiarly coloured. Less convex than *C. insularius*, the head and prothorax relatively narrower, the lateral and apical suffusion of the elytra more extended and more sharply defined.

4. **Cyphon mahensis**, sp. n.

Oblong, narrow, convex, very shining, pubescent; nigro-piceous, the antennae (the infuscate terminal joints excepted) and legs (the infuscate femora excepted) testaceous; the head and prothorax sparsely, minutely, the elytra much more distinctly but not very closely, punctured. Head much narrower than the prothorax, the eyes rather small; antennae long, slightly thickened at the tip, joint 11 stouter than 10. Prothorax short, rounded and sharply margined at the sides, narrowed anteriorly. Elytra oblong, relatively elongate, narrowing from about the middle, separately rounded at the tip, unimpressed.

Length 1½ mm.

Loc. SEYCHELLES: Mahé; Mare aux Cochons district, 1000–2000 feet, 26. i.–2. ii. 1909.

One specimen. A very small, oblong, convex, uniformly nigro-piceous form. It is the smallest *Cyphon* known to me.

Two specimens of another small black member of the genus, with more coarsely punctured elytra, were captured by Dr. Scott in Mahé,* but they are too imperfect for description. The Antillean *C. caraibus* Champ. is a somewhat similar, broader insect.

5. **Cyphon biperforatus**, sp. n.

Oblong-oval, narrow, rather convex, shining, closely pubescent; brown, the head reddish, the basal two joints of the antennae, the

---

* One in the damp forest at the summit of Morne Pilot, over 2000 feet, x. or xi. 1908, the other from between the leaf-bases of a growing endemic palm (*Verschaffeltia*) near Morne Blanc, also x. or xi. 1908.

elytral fossae, under surface, and legs, testaceous; the entire surface densely, finely punctured. Head not very broad, the eyes small; antennae long, slender. Prothorax very short. Elytra oval, not wider than the prothorax at the base, somewhat acuminate at the sutural angle; each with a very deep, oblique, perforation at the base adjacent to the scutellum.

Length 2 mm. (♀?).

Loc. SEYCHELLES: Mahé; Cascade Estate, about 1000 feet or above, iii. 1909.

One example, in a perfect state of preservation. Similar, but shallower, fossae at the base of the elytra are to be found in the females of *C. quadrifoveolatus* Champ. and other Central American species, the cavities being present in that sex only. The wings seem to be wanting in the Silhouette insect, so far as can be seen without detaching the somewhat transparent elytra.

6. Scirtes seychellensis, sp. n.

Oval, shining, thickly clothed with rather long yellowish pubescence; piceous, the basal joints of the antennae, prothorax, the outer margins of the elytra to about the middle and the humeri to a greater or less extent, and legs (the lower surfaces of the femora in part excepted), testaceous; the elytra densely and rather strongly, the rest of the upper surface minutely, punctate. Antennae long, slender. Prothorax very short, rapidly narrowing from the base, the sides forming an almost continuous outline with those of the elytra. Elytra narrowly margined. Beneath densely punctulate. Posterior coxal plates obtusely angulate externally. Posterior tibiae moderately explanate, the upper spur twice the length of the lower one.

Length 1¾—2 mm.

Loc. SEYCHELLES: Silhouette, Mahé. Silhouette; Mare aux Cochons, over 1000 feet, viii. 1908, one example. Mahé; near Morne Blanc, about 1000 feet, xi. 1908; Mare aux Cochons district, 1000–2000 feet, 26. i.–2. ii. 1909, several specimens, including four from a marsh at the summit of a pass (2000 feet); Cascade Estate, 1000–2000 feet, ii.–iii. 1909.

Twenty-three specimens. A small oval form, piceous in colour, with the prothorax, the sides of the elytra anteriorly, and the legs (except the femora beneath), testaceous. No

external sexual marks of distinction are visible. Amongst the Eastern species known to me, *S. seychellensis* is nearest allied to *S. quadrifoveatus* Champ., from Dikoya, Ceylon, differing from the latter in its more ovate shape, longer antennae, darker head, and more strongly punctured elytra; the ♀, moreover, of the Ceylon insect has each elytron foveate near the apex, no trace of an impression being visible in any of the Seychelles specimens. These latter must represent an endemic form; many islands, including Fiji, have one or more representatives of the genus.

7. **Ptilodactyla scabrosa**, sp. n.

♂. Oblong-elliptic, moderately convex, shining, thickly clothed with rather coarse yellowish pubescence; piceous or dark brown, the sides or anterior portion of the prothorax and the base of the elytra often paler or reddish, the antennal joints 1 and 2, palpi, femora, and tarsi testaceous, the rest of the antennae blackish or infuscate; the entire upper surface closely, roughly punctured, the elytra finely striate throughout. Antennae about as long as the body, joint 2 very short, the articulated ramus arising from the base of each of the joints 4–10 long and slender, the outer ones longer than the actual joint itself. Prothorax strongly transverse, somewhat gibbous, rapidly narrowing from near the base, the sides rounded posteriorly, the base trisinuate, the margin very finely, obsoletely crenulate. Scutellum concave, notched in front. Elytra moderately long, oblong-oval, sharply margined at the sides. Beneath finely punctured; fifth ventral segment triangularly emarginate at apex. Tarsal claws rectangularly widened in their basal half.

Length 2¾–3 mm.

Loc. Seychelles: Silhouette, Mahé. Silhouette; at or near Mare aux Cochons, about 1000 feet, viii.–ix. 1908, ten specimens. Mahé; near Morne Blanc, about 1000 feet, x. 1908, two examples.

Twelve ♂♂. This insect is related to various unnamed Javan forms in the British Museum. It is a small, dark brown or piceous, roughly punctured insect, with very elongate, strongly ramose, blackish antennae in ♂, finely striate elytra, and testaceous femora and tarsi. Numerous species of this genus from the Malayan Islands, etc., were named by Pic in 1916 and 1917, but the present insect is scarcely likely to be one of them.

Cantharidae (= Telephoridae).

8. **Caccodes debilis** Sharp.

Caccodes debilis Sharp, Trans. Roy. Dublin. Soc. (2) iii, p. 157 (1885).

Loc. Seychelles: Mahé; Cascade Estate, between about 800 and 1500 feet, i.–iii. 1909.

Two specimens of this minute Telephorid were captured in Mahé, these agreeing with the Hawaiian types in the British Museum. *C. debilis* is very like a small immaculate *Malthodes*, and is recognisable by the long stout antennae (♀ in ♂ only), the very short, transversely subquadrate, mesially-excavate prothorax, and the short divaricate elytra, the long wings being thus in great part exposed. Where this species is endemic, it is impossible to say.

Melyridae.

9. **Laius sericatus**, n. sp.

♂. Moderately elongate, rather broad, somewhat shining, clothed with extremely fine, greyish, sericeous pubescence; bluish-green, the antennal joints 1–3 testaceous, the joints 4–10 and the legs black; the entire upper surface densely, very minutely punctured. Head rather broad, subtriangular, slightly depressed and obsoletely canaliculate in the middle betweeen the eyes, the latter rather prominent; antennae with a long, curved, outwardly-dilated, externally-excavate basal joint, the second joint extremely broad, large, concave, ear-shaped, 3 articulated to it at about the middle of its distal margin, 3–9 short, similar, 10 ovate. Prothorax convex, transverse, wider than the head, rounded at the sides, a little narrower at the base than at the apex. Elytra subparallel, moderately long, wider than the prothorax, separately rounded at the tip. Legs stout; anterior femora thickened, broadly, obliquely sulcate beneath; anterior tibiae greatly thickened, becoming much narrower at the apex, convex externally, sulcate within.

Length 4, breadth 1¾ mm.

Loc. Seychelles: Félicité Island, 14–17. xii. 1908, one ♂. [Félicité is one of the smaller islands, reaching no great elevation, and mostly cultivated, while the wild forest which remains in it is not of a specially endemic type; the insect may therefore be a non-endemic form.]

This insect belongs to Group A of the Key of the Asiatic

species of the genus given by me in the Ann. and Mag. Nat. Hist. (9) vii, p. 323 (1921), and comes near the Malayan *L. flavicornis* F., and the N.W. Australian *L. purpureipennis* and *L. alleni* Lea. The enormous, ear-shaped, transverse, second antennal joint is simply concave externally, and the puncturing of the upper surface of the body is extremely fine and dense. *L. flavicornis* lives upon the seashore.

10. **Xamerpus (?) cioides**, sp. n.

Oblong, convex, shining, thickly clothed with soft, fine, semi-erect, greyish hairs, with scattered, erect, longer hairs intermixed; nigro-piceous or black, the margins of the prothorax and the whole of the elytra sometimes brown, the legs and antennae testaceous, the latter (the basal joints excepted) more or less infuscate in some examples; the head finely, the prothorax closely, coarsely, confusedly punctured, the puncturing of the prothorax usually finer and more diffuse than that of the elytra. Head rather broad, the eyes prominent; antennae extending beyond the base of the prothorax, joint 3 elongate, 4–10 triangular, gradually increasing in width, 11 stout, ovate. Prothorax strongly transverse, rounded at the sides, rapidly narrowing anteriorly, narrowly margined. Scutellum rather large. Elytra moderately long, of the same width as the prothorax at the base, conjointly rounded at the tip. Beneath very finely punctured; prosternum narrowly produced between the anterior coxae. Legs short, rather stout; tarsal joints 2–4 very short, subequal, 1 a little longer than 2, the claws with a long, free, membranous appendage.

Var. *a*. Elytra with a common, oblong or elongate testaceous patch extending from below the base to near the apex.

Var. *β*. Prothorax testaceous or rufo-testaceous; the elytra as in *a*.

Lenth $1\frac{3}{4}$–$2\frac{1}{2}$ mm. (♂♀).

Loc. SEYCHELLES: Silhouette, Mahé.

(1) Type-form; 30 specimens from Silhouette (endemic forest near Mont Pot-à-eau, about 1500 feet, viii. 1908; Mare aux Cochons and high forest above, over 1000 feet, viii.–ix. 1908); 11 from Mahé (near Morne Blanc, about 1000 feet; summit of Morne Pilot, over 2000 feet, xi. 1908; Morne Seychellois, 1500–2000 feet, ii. 1909; Cascade Estate, about 1000 feet, ii.–iii. 1909).

(2) Var. *a*, 22 specimens from Mahé (near Morne Blanc, summit of Morne Pilot, etc., 1000 to over 2000 feet; Mare aux Cochons district, 1000–2000 feet; Cascade Estate, about

1000 feet); 2 from Silhouette (near Mont Pot-à-eau, and Mare aux Cochons, both over 1000 feet).

(3) Var. *β*, 8 specimens from Mahé (forests of Morne Blanc and Morne Pilot; Cascade Estate; forest of stunted "Capucin" (*Northea*) trees on a mountain-summit in the Mare aux Cochons district, over 2000 feet, ii. 1909); 1 from Silhouette (near Mont Pot-à-eau).

A very variable insect, upwards of 70 examples of which were captured by Dr. Scott. The above list shows that the majority of specimens of the type-form were taken in Silhouette, while those of the forms with maculate elytra are almost all from Mahé. The type-form and its varieties seem to be confined to the endemic forests, in which they occur up to the highest and dampest parts; they were met with through all the months from August to March. The name *cioides* was suggested by the resemblance of the insect to a *Cis*, and a species of that genus coloured like the var. *a* was found in small numbers both in Mahé and Silhouette.

This species is allied to, and no doubt congeneric with, the equally inconstant S. Indian Dasytid identified by me in 1922 (Ent. Mo. Mag. lviii, p. 128) as *Donaldia* (*Xamerpus*) *maindroni* Pic, differing from the latter in the shorter antennae and legs, the less expanded margins of the prothorax, and the system of coloration of the varietal forms. The differences between the two genera mentioned are somewhat uncertain, and both of them come very near *Malthacodes*, Waterh. (1876), based upon a single species from Rodriguez. *Donaldia*, type from Mauritius, has more dilated antennae and a much broader prothorax. *Xamerpus*, ten species of which have been recorded from Madagascar, all unknown to me, is said to have a broad, dentate, 5-jointed antennal club. The maxillary palpi in the Seychelles insect, as in *D. maindroni* and *Malthacodes*, have a very broad securiform apical joint, and the corresponding joint of the labial palpi is also securiform. The two Indian species referred by me to *Haplocnemus* (*loc. cit.* p. 127) are also very nearly related to *Xamerpus*. The ♂ of *X. cioides* is narrower and more cylindrical than the ♀.

Cleridae [Supplement].

A report by S. Schenkling on the Cleridae of the Percy Sladen Trust Expedition was published in Tr. Linn. Soc. London, ser. 2, Zool., xviii, pp. 325–329 (1922). The single specimen described below was, through its superficial resemblance to

a Helodid, placed under that family, and hence was not submitted to Dr. Schenkling with the other Cleridae.

11. **Allochotes praslinensis**, sp. n.

♂. Broad oval, shining, thickly clothed with rather long, semi-erect yellowish hairs; testaceous, the eyes, tips of the mandibles, and elytra (a common sutural stripe extending down the basal two-thirds excepted) black; the head and prothorax sparsely, minutely, the elytra more closely and much more distinctly, punctured, the space occupied by the sutural stripe with numerous coarser punctures intermixed. Head short, broad, truncate at the apex, leaving the mandibles partly exposed, hollowed in the middle anteriorly, the epistoma confused with the front; eyes very large, emarginate in front; antennae moderately elongate, joints 2 and 3 small, 4–10 triangular, stout, rapidly widening, about as long as broad, 10 subtransverse, 11 ovate. Prothorax transverse, much wider than the head, moderately convex, rounded at the sides. Elytra convex, broad, transversely subcordate, greatly dilated at the sides anteriorly, at the base not wider than the prothorax, the humeral callosities not very prominent. Legs stout.

Length (extended) 3¼, breadth 2¼ mm.

Loc. SEYCHELLES: Praslin, xi. 1908, one ♂.

This insect, when rolled up (*i.e.* with the head and prothorax deflexed), has the general facies of a *Coccinella* or *Scirtes*. There are one or two similarly-coloured allied unnamed forms from Ceylon in the British Museum. The present species is doubtless a native of the Seychelles.

XVII. *The Dragonflies* (*Order* Odonata) *of Fiji, with special reference to a collection made by Mr. H. W. Simmonds, F.E.S., on the Island of Viti Levu.*

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[Read October 3rd, 1923.]

(With Twenty-one Text-figures.)

Up to the present time little work has been done upon the Odonata of the Fiji Islands, the only outstanding contribution to our knowledge being the fine paper by de Selys on the genus *Nesobasis* (Ann. Soc. Ent. Belg., xxxv, 1891, pp. li–lvii, Brussels). Including the five species of this genus, all of which are peculiar to the Fiji Islands, only sixteen species have so far been recorded for the group, and several of these are widely spread in Australia and the Pacific Islands.

In June, 1919, Mr. H. W. Simmonds, F.E.S., Acting Government Entomologist in Fiji, wrote to me to ask me to name a specimen of a common dragonfly caught on the Waidoi Estate near Navua, Viti Levu, where he was then stationed. In replying to his letter, I drew his attention to de Selys' work on the genus *Nesobasis*, and suggested that the Zygoptera of Fiji would be well worth collecting, and that very probably some new species of this interesting genus would soon be discovered. Mr. Simmonds acted upon this advice, and proceeded to collect Odonata, particularly Zygoptera, with great vigour during the remainder of his stay at Waidoi, viz. from August to November of the year 1919. Fortunately Mr. Simmonds is gifted with great skill as an artist in colours, and willingly acted on a suggestion which I made to him that he should make water-colour drawings of all the species taken before their colours faded.

The result was a fine series of coloured drawings which are well worthy of publication, were it not for the prohibitive cost of coloured plates at the present time. During that time, Mr. Simmonds collected, in spite of very bad weather, no less than 170 specimens of Odonata. These were forwarded to me in several consignments, and together constitute what I propose to designate as the Simmonds Collection in this paper. Nearly all of these were taken in and around Waidoi, a plantation situated not far from Navua on the Island of Viti Levu. Of this region, Mr. Simmonds says: " This belt of country is different from most of Fiji, and is geologically the oldest portion. From a few miles west of Suva to a few miles west of Navua, there is a belt of volcanic country subjected to a rainfall of 180 inches and upwards per annum. It has many clear water streams flowing through heavy forest. It is here that almost all the species have been taken."

The Simmonds Collection, when analysed, is found to contain twenty-three species, of which no less than thirteen are new to science. Of the new species, all of which belong to the Zygoptera, ten are referable to the genus *Nesobasis*, which is the dominant genus of dragonflies in the group, one to *Pseudagrion*, one to *Agriocnemis*, and one to *Austrolestes*, the latter being the first record, as far as I know, of a representative of the family Lestidae in these Islands. As only ten species already recorded from the group are absent from the Simmonds Collection, I thought it advisable to include these also in the paper, so as to make a comprehensive survey of the total known Odonate fauna of the Islands.

Before proceeding to enumerate and describe the species, I wish to express my great admiration for the careful way in which Mr. Simmonds carried out the work of collecting these insects. Not only was each specimen carefully papered, with locality and date, but most of the specimens had very detailed notes as to coloration, etc., and the particular specimens drawn in colours were all specially labelled. It has been a great pleasure to work through such a well-prepared collection, and I wish to express to Mr. Simmonds my very sincere thanks for the opportunity of so doing. I also wish to thank Mr. Herbert Campion, Odonatologist in the British Museum of Natural History, for his valuable help in collecting together a complete record of the Odonata of these Islands.

The holotypes and allotypes of the new species described in this paper have been placed in the Cawthron Institute Collection. New Zealand being comparatively close to Fiji, this should facilitate any further work which may be carried out in the study of Fijian Odonata. Mr. Simmonds desired that named paratypes of the new species, where available, and also named duplicates of species already known, should be sent by me to the British Museum, and also to the Dominion Museum, Wellington; this has already been done. Further named specimens have also been sent to the Department of Agriculture at Suva, Fiji, together with the series of coloured drawings made by Mr. Simmonds, which should be most useful for reference on the spot. In the descriptions of new species given in this paper, full use has been made of Mr. Simmonds' copious notes on coloration, etc., and the coloured drawings have also been carefully studied so that the correct colours might be embodied in the description wherever possible. Thus it will be seen that, in dealing with *Nesobasis erythrops* Selys, the last two segments of the abdomen are shown to be marked with bright blue above. This colour was not noticed by de Selys, and would probably not have been noticed by me either, if I had not had Mr. Simmonds' note and drawing before me, so that I could turn to the faded specimen and by careful study make out the exact area of the blue coloration, which fades in the dead insect almost to black. Several other instances could be given where very bright colours, chiefly blue, had so faded that they could well have been overlooked in the description.

The paper concludes with a short analysis of the zoo-geographical elements which make up the Fijian Odonate fauna.

The following is a complete list of the known dragonflies of the Fiji Islands, those species marked with an asterisk being absent from the Simmonds Collection. No doubt many more species could be added if other islands besides Viti Levu were to be carefully worked.

Sub-order *ZYGOPTERA*.

Family LESTIDAE.

1. *Austrolestes vitiensis* n. sp.

Family AGRIONIDAE.

2. *Pseudagrion pacificum* n. sp.
3. *Nesobasis erythrops* Selys.
*4. " *telegastrum* Selys.
*5. " *longistyla* Selys.
6. " *flavilabris* Selys.
7. " *corniculata* n. sp.
8. " *simmondsi* n. sp.
9. " *comosa* n. sp.
*10. " *nigrostigma* Selys.
11. " *angulicollis* n. sp.
12. " *subhumeralis* n. sp.
13. " *selysi* n. sp.
14. " *campioni* n. sp.
15. " *aurantiaca* n. sp.
16. " *brachycerca* n. sp.
17. " *heteroneura* n. sp.
18. *Agriocnemis exsudans* Selys.
19. " *vitiensis* n. sp.
20. *Ischnura heterosticta* Burm.
21. " *aurora* Br.

Sub-order *ANISOPTERA*.

Family AESCHNIDAE.

22. *Anaciaeschna jaspidea* (Burm.).

Family LIBELLULIDAE.

*23. *Synthemis macrostigma macrostigma* Selys.
24. *Procordulia irregularis* Martin.
*25. *Hemicordulia tau* Selys.
*26. *Hypothemis hageni* Karsch.
27. *Orthetrum sabina* (Drury).
*28. *Lathrecista asiatica asiatica* (Fabr.).
29. *Diplacodes bipunctata* (Br.).
*30. *Diplacodes trivialis* (Ramb.).
*31. *Pantala flavescens* (Fabr.).
*32. *Tramea limbata* (Desjardins).
33. *Rhyothemis phyllis dispar* Br.

Sub-order *ZYGOPTERA.*

Family LESTIDAE.

Genus AUSTROLESTES Till.

1. **Austrolestes vitiensis**, n. sp.

(Text-fig. 1.)

♂. *Total length* 42, *abdomen* 34, *fore-wing* 22 mm.

Head:—*Eyes* dark blue above, light blue beneath. *Antennae* blackish; *ocelli* transparent yellowish brown. *Epicranium, frons*

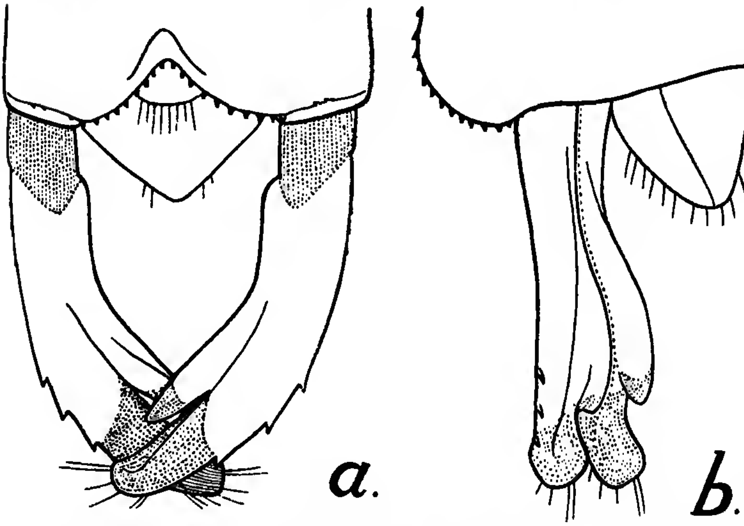


FIG. 1.—*Austrolestes vitiensis* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 40).

and *postclypeus* blackish; *anteclypeus* and *labrum* blue-green; *labium* pale testaceous.

Thorax:—*Prothorax* blackish above, the posterior lobe deep metallic greenish; sides pale testaceous with a superior black patch. *Synthorax* metallic green above, with a narrow dark stripe along the mid-dorsal carina; mesinfraepisternum blackish above, pale testaceous below; humeral suture brownish, with an anterior black mark and a short posterior black stripe. Sides light blue, shading to pale testaceous on breast; first lateral suture with a rather flattened **J**-shaped mark in middle, metallic green; second lateral suture with a narrow triangular blackish streak posteriorly. *Legs*

pale testaceous, femora striped above and below with blackish, hairs also blackish; tibiae with a blackish stripe above; tarsi and claws blackish.

Abdomen:—dull blackish above, yellowish tinged with blue on sides of 1–5 and basal two-thirds of 6, and patches of same colour low down on sides of 9–10. Seg. 10 with apical margin incised in the middle, denticulate. *Appendages*:—Superiors 1·2 mm., forcipate, stout, very pale straw-coloured, with bases and tips blackish, bases slightly constricted; the outer margin carries three strong teeth on its distal two-fifths; the inner margin has a strong projecting lobe at one-fourth from apex, as shown in Text-fig. 1. Inferiors obsolescent. Seg. 10 carries postero-ventrally a fairly prominent median pyramidal tubercle.

Wings:—hyaline, with blackish venation. *Pterostigma* 1·3 mm., blackish, the veins forming the anterior and posterior margins thickened, jet black, the colouring just within these slightly brownish; covering about two cellules. *Postnodals* 11–12. *Quadrilateral* narrow, with the posterior angle sharply acute, but the distal side is not continued straight on to the posterior border of the wing as in *A. cingulatus* Burm. and some other species of the genus.

♀. *Total length* 40, *abdomen* 32·5, *fore-wing* 23 mm.

Generally similar to male, but with the thorax a little larger, the abdomen a little shorter and considerably stouter, more cylindrical. It differs in the following points:—*Eyes* pale greenish beneath. *Legs* brownish, the femora and tibiae with black stripes above, the knees strongly black. *Abdomen* with 1–2 metallic greenish above, sides yellowish; rest of abdomen dark bronze-green above, the sides light brown. *Appendages* 0·6 mm., narrowly conical, pale testaceous. Ovipositor reaching to about end of seg. 10. *Wings* with pterostigma 1·6 mm. long, and 12–13 postnodals.

Types:—A unique pair, holotype male and allotype female, in Cawthron Institute Collection.

Habitat:—Suva, Fiji Is., taken by Mr. H. W. Simmonds on Dec. 21st, 1919.

This species would appear to be rather closely allied to *A. paludosus* Till., from N. Queensland, but is easily distinguished from it by the metallic-green colouring of the thorax and the form of the internal lobe of the superior appendages of the male, which comes closest in shape to that of the very distinct *A. aridus* Till. from Central Australia.

Family AGRIONIDAE.

Genus PSEUDAGRION Selys.

2. **Pseudagrion pacificum**, n. sp.

(Text-figs. 2, 3.)

♂. *Total length* 34, *abdomen* 27·5, *fore-wing* 18 mm.

Head (Text-fig. 2*a*):—*Eyes* blue, bordered with paler blue beneath. *Ocelli* transparent red-brown. *Antennae* with segs. 1–2 blue, the rest missing. *Occiput* with the median area blue with a fine black edging, the postocular areas black, with very large rounded *post-ocular spots* of a bright blue, not connected by a median line. *Epi-*

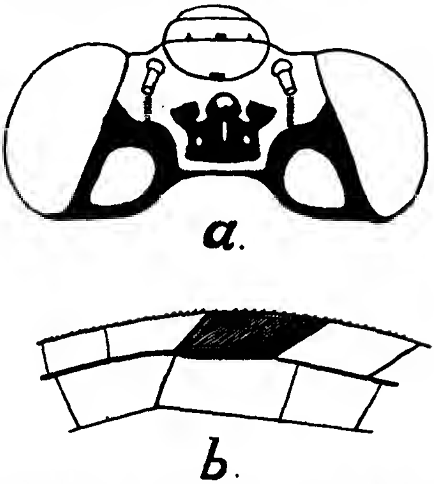


FIG. 2.—*Pseudagrion pacificum* n. sp., ♂. *a*, head, showing colour-pattern of blue and black (× 16). *b*, pterostigma of fore-wing (× 20).

cranium bright blue, with an irregular black area on the vertex enclosing the three ocelli; on this area, behind the median ocellus, is a fine dash of blue. *Frons, clypeus* and *labrum* bright blue; a small median black spot at base of frons, and three small black spots at base of postclypeus; *labium* dull brownish.

Thorax:—*Prothorax* black above, with a pair of rather large blue spots; sides blue. *Synthorax* bright blue, with a mid-longitudinal band of black, slightly widened in front at the collar; on the anterior two-thirds of this band is a much narrower blue stripe enclosing the dorsal carina, which itself carries a black line; humeral

suture with a well-marked black line; rest of sides bright blue; breast pale brownish. *Legs* dull fuscous above, pale brownish below.

Abdomen:—1–2 bright blue, with a narrow apical ring of black; 2 also with a squarish black patch covering the third quarter of the segment dorsally; 3–7 black above, with a narrow basal blue ring, spreading out distad on the sides; 8–10, bright blue; underside yellowish. *Appendages*:—Superiors, 0·4 mm., black, the apex blunt, bifid in lateral view; seen from above, there is a broad concave lobe extending inwards from base nearly to apex. Inferiors, 0·3 mm., black, subconical, apex broadly rounded. (Text-fig. 3.)

Wings hyaline, with black venation. *Pterostigma* 0·9 mm., covering less than one cellule, trapezoidal, the anterior distal angle very acute, as shown in Text-fig. 2*b*; colour dark fuscous with slightly

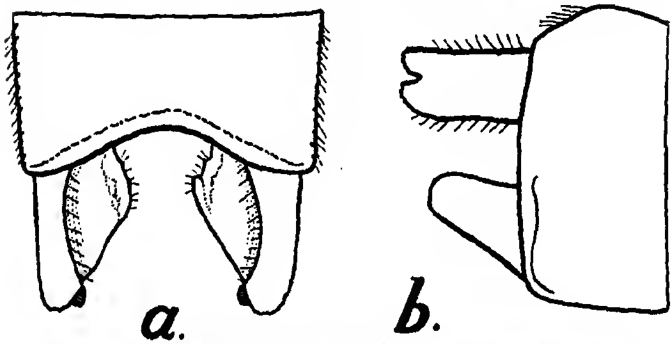


FIG. 3. *Pseudagrion pacificum* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

paler edging, the whole surrounded by very thick black veins. *Postnodals* 12; M_2 arising 5 cellules distad from nodus, and M_{1A} 4 cellules further distad, and only 1 cellule short of the pterostigmatic brace-vein.

♀. Unknown.

Type:—Holotype male in Cawthron Institute Collection.

Habitat:—Waidoi Plantation, Sept. 15th, 1919; taken by Mr. H. W. Simmonds.

This species is clearly allied to *Ps. australasiae* Selys from Australia, but can be at once distinguished from it by the greater amount of blue colouring on head, thorax and abdomen, especially by the blue and black pattern of the head, as shown in Text-fig. 2, the narrowness of the thoracic black bands, the difference in the pattern of seg. 2 of the abdomen, and the fact that the last three segments are

blue, only the last two being blue in the Australian species. The appendages are on a somewhat similar plan, but *Ps. australasiae* has the lower apical lobe of the superior appendage considerably larger than the upper one, and the inferior appendages are much shorter than in the Fijian species.

Genus Nesobasis Selys.

(Text-fig. 4.)

This is the dominant genus of Odonata in the Fiji Islands, and will probably be found to contain a very considerable number of species when the bush streams of the different islands are carefully worked. De Selys originally described five species from Fiji. Of these, only two can be recognised in the present collection; on the other hand, there are no less than eight new species in it which may be referred to this genus, making a total of thirteen. The genus is only represented, outside of the Fiji Islands, by a single species, *N. ciliata* Ris, from Bivak Island, South-west New Guinea; this species differs considerably from the majority of the Fijian species by the shortened and very little zig-zagged Cu_2, and also by the exceedingly close origins of M_3 and Ms.

The species placed in this genus vary greatly in facies, some of them having exceedingly long and slender abdomens, others much shorter ones and comparatively much stouter. They also differ much in coloration, some being marked with bright blue and resembling species of *Pseudagrion*, others being of dull coloration and with more of the facies of *Telebasis*, while one species has both red and blue coloration, as in *Xanthagrion*. It seems clear that the genus could easily be split up into a number of groups of at least subgeneric rank; this should not, however, be attempted until much more material has been collected and studied. In the meanwhile, the genus as it stands can be at once recognised by the combination of the following simple characters:—No bright *postocular spots* present. *Prothorax* similar in both sexes, without any specialised hooks or other armature in the female. *Postnodals* numerous, from 12 to 20 in number. *Anal bridge* (*Ab*, Text-fig. 4) arising at the anal crossing, as in *Pseudagrion* and allies, and the *petiolation* of the wing reaching as far as this, or very slightly beyond; this level is some distance basad from that of the second antenodal.

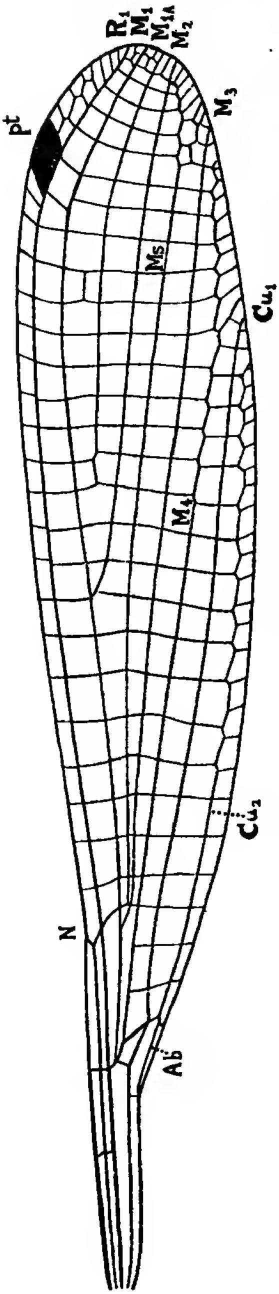


Fig. 4.—*Nesobasis flavilabris* Selys. Fore-wing. ♀. Comstock-Needham notation for the veins, except *Ms*, the Zygopterid sector; *Ab*, anal bridge; *N*, nodus; *pt*, pterostigma.

Genotype:—*Nesobasis erythrops* Selys (by priority of description).

The genus seems to lie between *Austroagrion* and *Xanthocnemis* on the one hand and *Teinobasis* on the other. One of the new species here described (*N. heteroneura* n. sp.) might well be taken for an *Austroagrion* but for the absence of the postocular spots, the considerably longer M_{1A} and Cu_2, and the larger size of the insect; it has the origins of M_3 and Ms not so close together as in the other species. This insect would run down, in a dichotomous key, to the African genus *Argiagrion*, except for its much smaller size; but I have little doubt that other characters would separate it widely from that genus, and have decided to retain it in *Nesobasis* for the present. The known species can then be separated by the following Key:—

KEY TO THE SPECIES OF THE GENUS *NESOBASIS* SELYS.

1. New Guinea species, with the origins of M_3 and Ms exceedingly close together . . . . *N. ciliata* Ris.
   Fijian species . . . . 2.
2. Species with the facies of a *Pseudagrion*, the distance between the origins of M_3 and Ms at least as long as the basal descending piece of Ms itself . . . . *N. heteroneura* n. sp.
   Not such species, the distance between the origins of M_3 and Ms always less than the length of the basal descending piece of Ms . . . . 3.
3. Eyes, head and thorax bright red, with black markings. *N. erythrops* Selys.
   Coloration not as above . . . . 4.
4. Abdomen of male excessively long and slender, about 48 mm. *N. telegastrum* Selys.
   Males with the abdomen not excessively long and slender 5.
5. Males bronze black marked with tawny yellow, orange or reddish, including sides of thorax . . . . 6.
   Species not marked as above . . . . 9.
6. Superior appendages of male longer than seg. 10, inferiors very short . . . . *N. longistyla* Selys.
   Appendages not longer than seg. 10 . . . . 7.
7. Sides of thorax reddish; superior appendages of male excessively short, inferiors somewhat longer . . *N. brachycerca* n. sp.
   Sides of thorax yellow or orange; superior appendages of male longer than inferiors . . . . 8.

8. Superior appendages of male half as long as seg. 10, inferiors half as long as superiors; posterior lobe of prothorax rounded. *N. nigrostigma* Selys.

Superior appendages of male about as long as seg. 10, inferiors one-third shorter; posterior lobe of prothorax angulated. *N. aurantiaca* n. sp.

9. Rather large, robust species with dark coloration and without any blue markings; breast black; prothorax not angulated. 10.

Smaller species with very slender abdomens, coloration bronze-black with bright blue markings, at least on sides of thorax; prothorax angulated postero-laterally . . . . . . 13.

10. Labrum pale yellow . . . . 11.

Labrum dark . . . . 12.

11. Labrum entirely yellow, or with only a small basal dark mark; superior appendages of male without any cornicle or tooth. *N. flavilabris* Selys.

Labrum yellow with a distinct median dark patch at base; superior appendages of male with a small cornicle or tooth close up to apices on inner side . . . *N. corniculata* n. sp.

12. Male with seg. 10 greatly enlarged distally when viewed in profile; inferior appendages longer than superiors. *N. simmondsi* n. sp.

Male with seg. 10 normal; superior appendages exceedingly hairy and of the same length as inferiors. *N. comosa* n. sp.

13. Abdomen of male with bright blue coloration on segs. 8–10. 14.

Abdomen of male with segs. 8–10 entirely bronze black or black (rarely a fine blue line bordering segs. 9–10 distally). 15.

14. Segs. 8–10 of male entirely blue dorsally; sides of thorax blue to above humeral suture, with only a short black mark placed anteriorly just below humeral suture . *N. angulicollis* n. sp.

Seg. 8 of male blue only on distal half, 9–10 blue; sides of thorax blue only up to humeral suture, and having a long black band running beneath that suture for nearly the whole length of the pleuron . . . . . *N. subhumeralis* n. sp.

15. Superior appendages of male shorter than seg. 10, inferiors nearly as long as superiors; sides of thorax black with blue bands . . . . *N. selysi* n. sp.

Superior appendages of male longer than seg. 10, inferiors exceedingly short; sides of thorax blue . *N. campioni* n. sp.

3. **Nesobasis erythrops** Selys.

(Text-fig. 5.)

This exceedingly beautiful species has been drawn in colours by Mr. H. W. Simmonds from life; the original description of the dried and faded specimen by de Selys does not do justice to it. The colour of the head, eyes, thorax and sides of segs. 1–2 of the abdomen is a rich cerise, marked with black as described; the black abdomen is relieved apically by segs. 9 and basal half of 10 being bright blue above (this colour was not noticed by de Selys). The appendages of the male are figured in Text-fig. 5; superiors 0·4, inferiors 0·3 mm. long; some specimens have the superior appendages slightly more pointed than here shown. *Pterostigma* 0·5 mm., trapezoidal, reddish.

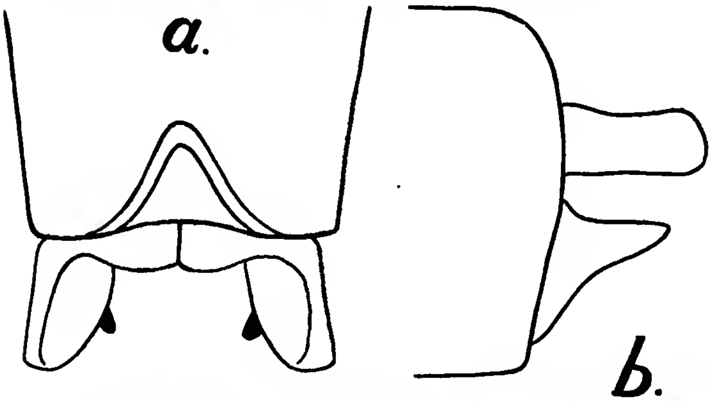


Fig. 5.—*Nesobasis erythrops* Selys, appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

Types :—Male and female, in Godeffroy Museum, Hamburg.

Mr. Simmonds' Collection contains four males of this species, taken on the Waidoi River, Sept. 10th, 11th (two), and Oct. 28th, 1919.

4. **Nesobasis telegastrum** Selys.

This very rare species can be at once recognised by the very long and slender abdomen and the black labrum and postclypeus, separated by the yellow anteclypeus. The appendages would appear to be somewhat similar in form to those of the preceding species.

Type :—Unique male in Godeffroy Museum, Hamburg. Not represented in the Simmonds Collection.

5. **Nesobasis longistyla** Selys.

Another very rare species, easily recognised by the form of the male appendages, the superiors being straight and longer than seg. 10, the inferiors very short and obtuse.

Type :—Unique male in Godeffroy Museum, Hamburg.

6. **Nesobasis flavilabris** Selys.

(Text-fig. 6.)

This is one of the commonest species of the genus, and is represented in the Simmonds Collection by no less than twenty-six specimens, thirteen being males and thirteen females, inclusive of six pairs taken *in cop.* These were

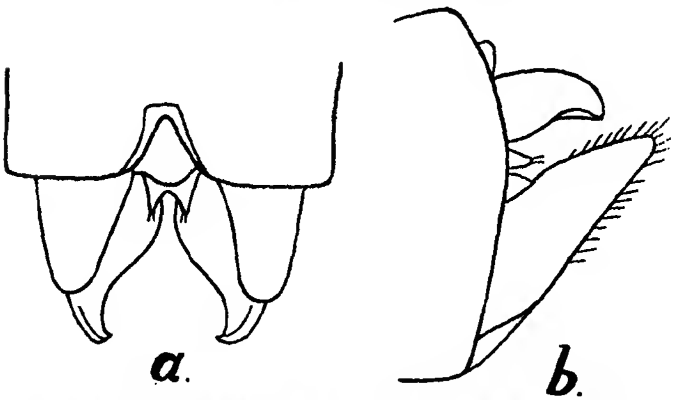


FIG. 6.—*Nesobasis flavilabris* Selys, appendages of male; *a*, dorsal view, *b*, lateral view (× 40).

all taken on the Waidoi River, during the months of May, Aug., Sept. and Oct., 1919, by Mr. Simmonds.

The species can be recognised by its very dark coloration, from which the pale yellow labrum stands out conspicuously. In most specimens the labrum is wholly yellow, but there are several in the collection in which there is a small blackish patch in the middle of the base of the labrum, always much smaller and less noticeable than that to be found on the labrum of the succeeding very closely allied species. The tip of the abdomen in the male, *i. e.* seg. 10 and the two pairs of appendages, is dark red in colour. The appendages of the male are shaped as shown in Text-fig. 6; superiors 0·4, inferiors 0·6 mm. long;

but there is some amount of variation in the size and shape of the peculiar small bifid process which can generally be seen projecting below and between the superior appendages. *Pterostigma* 0·6 mm., trapezoidal, the basal side very oblique, so that the anterior side is considerably shorter than the posterior. The female is generally not quite as dark as the male, and shows quite clearly a series of paler basal bands on segs. 3–8; when very mature, it becomes almost black like the male.

Types:—Several males and a female, in Godeffroy Museum, Hamburg.

This species is one of three very closely allied species of

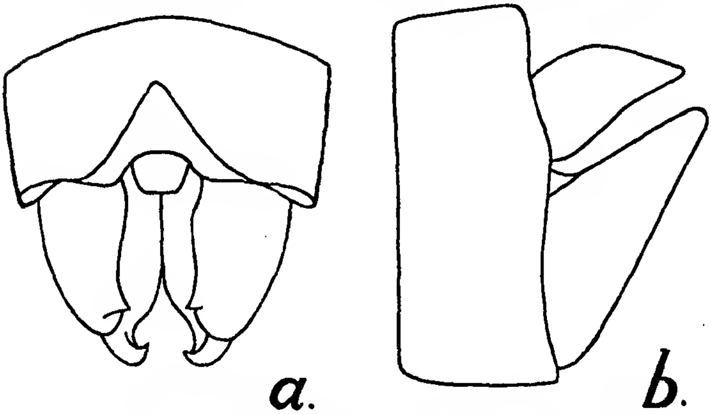


FIG. 7.—*Nesobasis corniculata* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 40).

very similar facies and coloration, in all of which the inferior appendages of the male are longer than the superiors, pointed and somewhat curved inwards.

7. **Nesobasis corniculata** n. sp.

(Text-fig. 7.)

♂. *Total length* 43, *abdomen* 36, *fore-wing* 24 mm.

Closely similar to the male of *N. flavilabris* Selys, with the same general form and black coloration, but differing from it as follows:— The *labrum* is yellowish, with a very distinct dark median patch basally, fuscous; this patch is considerably larger than the small basal patch which is found on the labrum of the variety of *N. flavilabris* mentioned above. Seg. 10 is dark brownish; the appendages bright red. The form of the *appendages* (Text-fig. 7) is

generally similar to those of *N. flavilabris*, but the superiors are longer, 0·5 mm., only about one-sixth or less shorter than the inferiors, and they carry on the inner margin, just before the apex, a very distinct cornicle or tooth projecting inwards transversely; there is also no bifid process, such as can usually be seen between and below the superior appendages of *N. flavilabris*. Viewed in profile, the superior appendage is broader, less nodding and more sharply pointed at the apex than in *N. flavilabris*. These differences are well seen by comparing Text-figs. 6 and 7. *Pterostigma* 0·7 mm., trapezoidal, anterior side less than posterior.

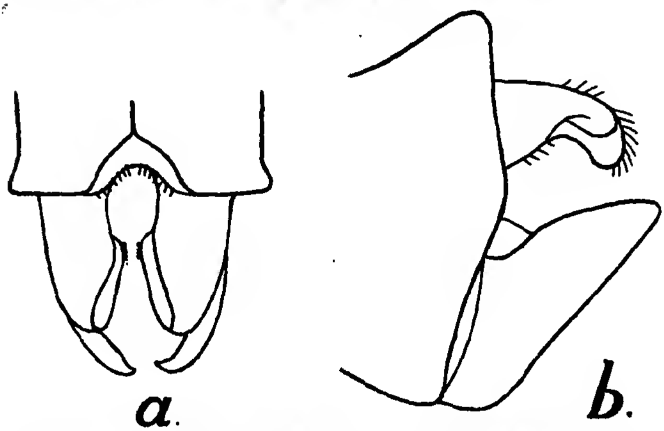


FIG. 8.—*Nesobasis simmondsi* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 30).

♀. *Total length* 44, *abdomen* 37, *fore-wing* 27·5 mm.

Closely resembles the female of *N. flavilabris*, from which it can only be distinguished with difficulty by the dark median patch on the labrum, the pale basal bands on segs. 3–6 broader and more clearly marked off, and the slightly longer appendages.

Types :—Holotype male and allotype female, in Cawthron Institute Collection, taken *in cop.*, Waidoi River, Fiji, Aug. 24th, 1919, by Mr. Simmonds. Also three paratype males, from same locality, May 18th and Aug. 31st, 1919, respectively.

8. **Nesobasis simmondsi** n. sp.

(Text-fig. 8.)

♂. *Total length* 46, *abdomen* 37, *fore-wing* 27 mm.

Though of somewhat larger size than the two preceding species,

this species shows a general close resemblance to them. The *abdomen* is dark brown, with pale basal rings on segs. 3–7. Seg. 10 and the appendages are a medium reddish brown in colour. The *labrum* and *anteclypeus* are both very dark brown, the *postclypeus* shining black. *Thorax* black, with brownish streaks irregularly placed on sides, and with the jet black breast surrounded with pale yellowish brown. *Legs* pale testaceous, with a dark line above on femora and a dark patch on knees. The species is, however, most easily recognised by the form of the *appendages* (Text-fig. 8). Seg. 10 is considerably enlarged, especially when viewed from the side, and carries a pair of very large inferior appendages, 0·8 mm. long, which, viewed from below, appear like a large forceps attached ventrally to the segment; these appendages are considerably longer than the superiors, which are only 0·6 mm. long, and are curved in apically much as in the two preceding species. The superiors are slightly hollowed out along the distal portion of their inner margin, and the same margin carries, about its middle, a short blackish projection or tubercle. The end of the tenth segment is raised up in the middle high above the superior appendages, and the incised median border carries a series of short bristles. *Pterostigma* 0·8 mm., rhombic, pale brown with darker lanceolate centre.

Type:—Holotype male, April 20th, 1919, and paratype male, Oct. 3rd, 1919, Waidoi River; taken by Mr. Simmonds; the former in Cawthron Institute Collection, the latter in British Museum Collections.

9. **Nesobasis comosa** n. sp.

(Text-fig. 9.)

♂. *Total length* 40, *abdomen* 32, *fore-wing* 24 mm.

Of the same general form as *N. flavilabris*, but with somewhat more slender abdomen. General colour dark slaty-black all over; *labrum* greenish black; *eyes* black above, green below; *legs* black, with a touch of reddish on the distal part of the hind tibiae; a touch of greyish pruinescence on sides of thorax, and more on the breast; superior *appendages* blackish, inferiors reddish brown. The *frons* carries a series of long, slender, light brown hairs, which project forwards in a regular row, their tips reaching well beyond the level of the anterior end of the labrum. The superior and inferior *appendages* (Text-fig. 9) are of about the same length, 0·5 mm. long, the superiors very hairy, especially around their apices, the inferiors of the usual triangular form, with the apices turned inwards and

strongly pointed. Seg. 10 is only weakly incised medially. *Pterostigma* 0·7 mm., trapezoidal, anterior side longer than posterior.

Type:—Holytype male, unique, Waidoi River, Aug. 24th, 1919, taken by Mr. Simmonds; in Cawthron Institute Collection.

10. **Nesobasis nigrostigma** Selys.

This species can be recognised by the *frons* and first three segments of the *antennae* being yellow, the *thorax* bronze above, with a yellow humeral line and the sides and breast yellow, the *abdomen* slender, of a bronze fuscous colour, brown on segs. 8–10, the legs yellowish, the *pterostigma* black, and the inferior *appendages* very short, only half as long as the superiors, which are pinched in at the tips.

♀. Unknown.

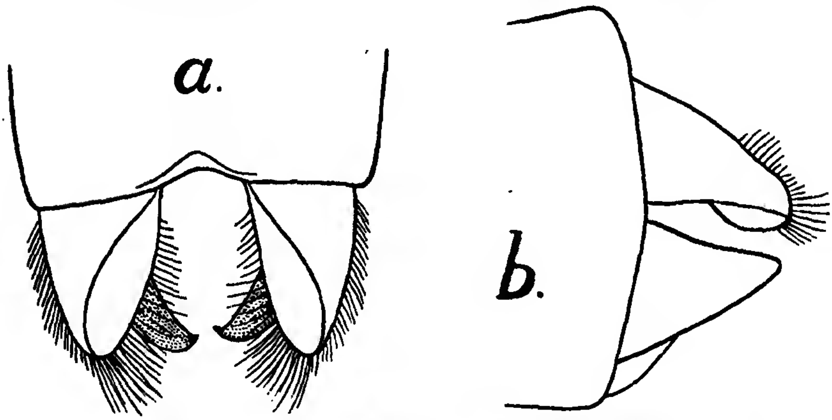


FIG. 9.—*Nesobasis comosa* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 40).

Type:—Holotype male, unique, in Godeffroy Museum, Hamburg. Not represented in the Simmonds Collection.

11. **Nesobasis angulicollis** n. sp.

(Text-figs. 10–12.)

♂. *Total length* 38, *abdomen* 31·5, *fore-wing* 22 mm.

Head:—*Eyes* brown above, green below. *Ocelli* semi-transparent brownish. *Antennae* brown. *Epicranium* black; *frons* with a transverse band of bright blue extending on either side on to the border of the eye. *Postclypeus* black; *anteclypeus* and *labrum* apparently blue, but somewhat darkened in the dead insect. *Labium* pale testaceous.

Thorax:—*Prothorax* with the pronotum strongly angulated postero-laterally, as shown in Text-fig. 10*c*, right side; bronze black and bright blue, the pattern being shown in the same Text-fig.; the black posterior mark on either side encroaches anteriorly on to the blue by a slender oblique pointed extension, directed forwards, so as to divide the blue anterior portion into three lobes, the middle of which is again divided mid-dorsally by a fine black line. *Synthorax* greenish black above, with a fine blue line along the mid-

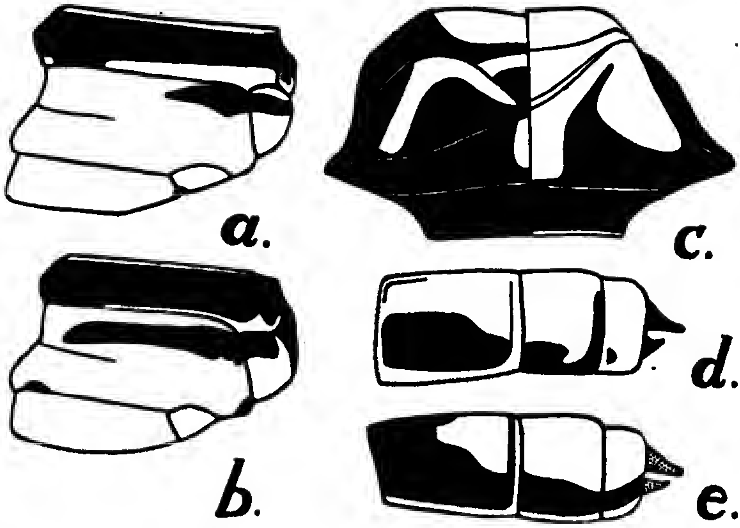


FIG. 10.—*a*, colour-pattern (blue and black) of thorax of male of *Nesobasis angulicollis* n. sp., lateral view. *b*, the same for male of *N. subhumeralis* n. sp. *c*, dorsal view of prothorax, the right half being that of the male of *N. angulicollis* n. sp., the left half that of the male of *N. subhumeralis* n. sp. *d*, lateral view of abdominal segs. 8–10 in *N. angulicollis* n. sp., male. *e*, same for *N. subhumeralis* n. sp., male (*c* × 34, all the rest × 12).

dorsal carina; the dark colour only reaches the humeral suture along the distal fourth of it, leaving a narrow blue band above the rest of the suture, as shown in Text-fig. 10*a*; sides almost entirely bright blue, there being a longitudinal black mark placed anteriorly just below the humeral suture, extending across the upper portion of the mesepisternum and backwards on to the mesepimeron, ending in a point before half-way; breast livid, slightly pruinose. *Legs*:—coxae, trochanters and underside of femora pale yellowish; upper side of femora and nearly whole of tibiae black; apical part of tibiae and whole of tarsi brownish.

Abdomen:—very slender, blackish above on segs. 3–7; segs. 1–2 and 8–10 bright blue above, this colour extending well down on the sides of seg. 8 distally, far down on the sides of seg. 9 altogether, and entirely around seg. 10 except for a small triangular basal spot of black low down on each side (Text-fig. 10*d*); sides and underside yellowish. *Appendages*:—Superiors 0·5 mm. long, wide apart, each consisting of a main lobe much hollowed out above on the inner side, and sending a basal prolongation inwards nearly parallel to the border of seg. 10; each prolongation ends inwardly in a broad tooth, the two teeth nearly meeting in the middle line, and leaving an oval gap between them, as shown in Text-fig. 11; viewed laterally, the superiors

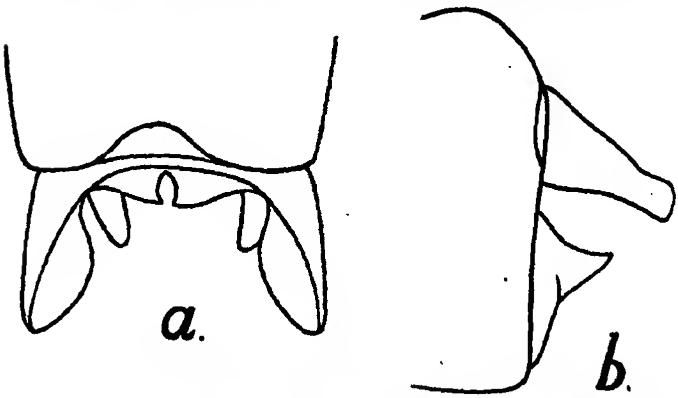


FIG. 11.—*Nesobasis angulicollis* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

appear somewhat truncated. Inferiors little more than half as long, broadly sub-triangular, the tips turned inwards and slightly upwards.

Wings:—*Pterostigma* 0·5 mm., narrowly rhomboidal, blackish with slightly paler edging, the whole enclosed by stout veins of jet-black colour; length slightly less than width, and covering barely one cellule. *Postnodals* 13. Origins of M_3 and Ms exceedingly close together, almost as close as in the New Guinea species *N. ciliata* Ris.

♀. *Total length* 34, *abdomen* 28, *fore-wing* 23 mm.

Somewhat similar to the male, but paler in colour; *labrum* dark olive green. *Prothorax* strongly angulated as in the male, but the blue and black pattern somewhat different owing to the black not dividing the blue so completely into three separate lobes (Text-fig. 12). *Legs* pale yellow, femora with a dark band above. *Abdomen*

mostly yellowish on sides and underside, dark bronze above except for most of seg. 9 and whole of seg. 10, which are blue; sides of segs. 1–2 also marked with blue. *Appendages* very short, subconical, dark; *ovipositor* yellowish, reaching well beyond end of appendages.

Types :—Holotype male and allotype female, in Cawthron Institute Collection, taken *in cop.*, Waidoi River, Aug. 26th, 1919, by Mr. Simmonds. Also two paratype males from same locality, dated Sept. 18th, 1919, and Oct. 4th, 1919, respectively.

This graceful and delicately built species is one of a series of four closely allied species which stand out very distinctly

FIG. 12.—*Nesobasis angulicollis* n. sp., prothorax of female, dorsal view (× 34).

from the *flavilabris* group by their smaller size and slenderer build, and also by their blue and bronze-black coloration. The form of the appendages connects them at once back to *N. erythrops* Selys, which also has blue markings on the end of the abdomen, but is otherwise a somewhat more robust and very differently coloured species. The angulated prothorax in both sexes is a feature of this group, but is most marked in the present species.

12. **Nesobasis subhumeralis** n. sp.

(Text-figs. 10, 13.)

♂. *Total length* 36, *abdomen* 30, *fore-wing* 22 mm.

Very closely allied to *N. angulicollis* n. sp., from which it can only be distinguished by the following characters:—*Eyes* black above, green beneath; *labrum* blue edged with black. *Prothorax* not so strongly angulated postero-laterally as in *N. angulicollis*, and with much less blue on it, as shown in Text-fig 10c, left side. *Synthorax*

bronze black above, with a fine blue line along mid-dorsal carina, and the black reaching exactly to humeral suture on either side; sides bright blue, but with a long and well-developed black band running just below the humeral suture, so as to isolate a narrow blue band on the upper portion of the mesepimeron; this black band runs to within a short distance of the posterior end of the pleuron, and also extends forwards well on to the mesinfraepisternum (Text-fig. 10*b*). *Abdomen* blackish above, with blue on sides of segs. 1–2; seg. 8 black above basally and on sides, blue above distally; segs. 9–10 blue above and on upper part of sides. Text-fig. 10*d*, *e* shows the difference in the pattern of segs. 8–10 in this and the preceding species. *Appendages* very similar to those of the preceding species,

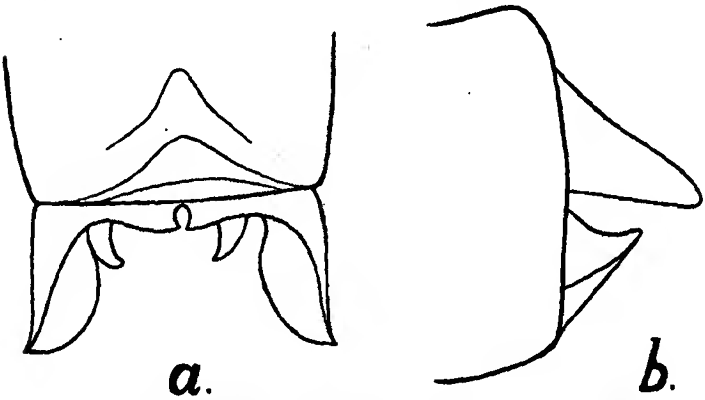


FIG. 13.—*Nesobasis subhumeralis* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

the superiors 0·5 mm. long, but more pointed apically, and with the points slightly turned outwards; seen in profile they are not so truncated; inferiors very broadly triangular, the tips turned well upwards and inwards. Both pairs of appendages are black in colour. Seg. 10 is perhaps slightly more incised medially than in the preceding species. (Text-fig. 13.) *Wings* very similar to those of the preceding species, but the *pterostigma* 0·6 mm., rhombic, exactly as long as broad, and covering just one cellule.

♀. Unknown.

Types :—Holotype male, Aug. 24th, 1919, and paratype male, Sept. 12th, 1919; both taken on the Waidoi River by Mr. Simmonds; the former in Cawthron Institute Collection, the latter in British Museum Collections.

13. **Nesobasis selysi** n. sp.

(Text-figs. 14, 15.)

♂. *Total length* 38, *abdomen* 32·5, *fore-wing* 21 mm.

Head rather small, barely 3 mm. wide. *Eyes* black above, green beneath. *Ocelli* semi-transparent brownish. *Antennae* black, shading to dark brown. *Epicranium, frons* and *clypeus* entirely black; *labrum* olive green, with numerous soft brownish hairs. *Labium* pale testaceous.

Thorax rather short and slender, less than 4 mm. long. *Prothorax* fairly small, angulated postero-laterally, but the angles not as prominent as in the two preceding species; colour metallic greenish black, the pronotum marked anteriorly with a somewhat trifoliate blue patch followed by a central blue patch more triangular

Fig. 14.—*Nesobasis selysi* n. sp., prothorax of male, dorsal view (× 34).

in shape, divided longitudinally by the black line of the dorsal carina, as shown in Text-fig. 14. *Synthorax* entirely black above, velvety, with a slightly greenish tinge in certain lights; sides also black, with two rich blue bands, one situated along the first lateral suture, beginning low down on the mesinfraepisternum, and reaching back about three-fourths the length of the pleuron; the other latero-ventral, running from behind the third coxa to the roots of the hind-wing; between these two bands there is a broad band of black, covering the second lateral suture; breast blackish, with dark grey pruinescence, the post-sternum pale testaceous. *Legs* mostly black; apices of the coxae, most of the trochanters and a spot at base of femora pale testaceous; distal part of tibiae and whole of tarsi brownish.

Abdomen:—very slender, black; seg. 1 with a blue spot on either side; underside yellowish brown. Segs. 9–10 are generally entirely black, but in some specimens each carries a narrow blue line around its distal border. *Appendages*:—Superiors short, only 0·3 mm. in

length, wide apart, diverging, apices fairly well rounded; between them there projects an obtusely triangular median lobe, as shown in Text-fig. 15. Inferiors very slightly shorter, with broad bases and narrow apices directed somewhat upwards and inwards. Seg. 10 very little incised medially.

Wings:—*Pterostigma* 0·5 mm., black, rhomboidal, covering one cellule. *Postnodals* 14–15. *Venation* black, the membrane slightly clouded with brownish in the adult male. Only one cross-vein (*i. e.* two cellules) between the origins of M_3 and Ms.

♂ Teneral:—In the very young male the thorax is bluish, or yellowish tinged with blue, on the sides, and there is no sign of the black lateral band; the legs also are pale testaceous all over. At

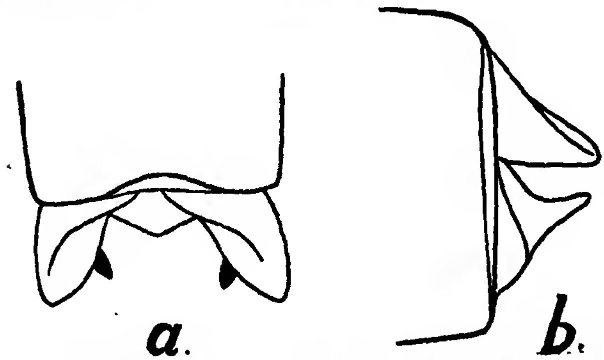


Fig. 15.—*Nesobasis selysi* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

a slightly later stage, the blue colour becomes bright on the thorax, but the black lateral band does not appear until the blue is already well established. The legs darken gradually. The amount of yellow on the underside of the abdomen is much greater in the teneral form than in the adult, and the spots on seg. 1 are yellowish at first. Probably the specimens showing fine blue apical lines on segs. 9–10 are not as mature as those in which these segments are entirely black.

♂ Aged:—In the aged male, the legs become almost entirely black, and the blue colour of the thorax deepens to a rich violet.

♀. *Total length* 37, *abdomen* 31, *fore-wing* 22·5 mm.

Differs from the male in the following points:—*Labrum* olive brownish, shading to yellowish along the margin. *Legs* testaceous yellowish. *Thorax* black above, with a fine blue line in the humeral suture; sides blue, without any band on the second lateral suture.

Abdomen with sides of seg. 1 almost entirely blue; a patch of bluish yellow on either side of seg. 2; underside of abdomen markedly brownish; sides of seg. 9 largely brownish also; general shape narrowly cylindrical, but not as slender as in the male. *Appendages* short, conical, brown. *Ovipositor* reaching to end of seg. 10 only, medium brown, with dark brown styles.

The teneral ♀ has the blue replaced by yellow.

Types:—Holotype male and allotype female, in Cawthron Institute Collection, taken *in cop.*, Waidoi River, Sept. 16th, 1922, by Mr. Simmonds. Also a series of nineteen males and seven females taken in the same locality during August to November, 1919, by Mr. Simmonds; this series includes several teneral forms of both sexes.

This species is closely related to the two preceding, but can be at once distinguished from them by the shorter appendages and the lack of conspicuous blue coloration at the end of the abdomen; also, the thorax is blacker, the broad black lateral band being quite distinctive for the species, except in the teneral forms.

14. **Nesobasis campioni** n. sp.

(Text-fig. 16.)

♂. *Total length* 36, *abdomen* 31, *fore-wing* 19 mm.

Head:—*Eyes* brown, orbits yellowish olive in front. *Ocelli* transparent brownish. *Antennae* dark brown. *Epicranium* and upper part of *frons* bronze black; rest of *frons* olive; *postclypeus* black; *anteclypeus* olive. *Labrum* blackish at base, shading to olive apically, with a touch of brown in the middle. *Genae* olive. *Labium* pale testaceous.

Thorax:—*Prothorax* black above, pale yellowish on sides; posterior lobe with rather blunt lateral angles. *Synthorax* bronze black above and on sides as far as first lateral suture; the humeral suture with a very slender brown line; sides blue, the second lateral suture with a touch of black near base of hind-wing; underside pale testaceous. *Legs* yellowish brown, with black hairs; femora broadly black above.

Abdomen entirely bronze black above, except for a little orange brown basally on seg. 1, a pair of small orange apical spots on seg. 2, and a basal ring of the same colour on seg. 3, interrupted by black mid-dorsally; sides and underside dull yellowish; seg. 10 very strongly hollowed out above. *Appendages*:—Superiors 0·5 mm.,

longer than seg. 10, subcornute and somewhat forcipate when viewed from above, and having a broad inner lobe occupying a little more than the middle third; seen in profile, they are somewhat clubbed; colour dull brown, shading to black at tips. Inferiors excessively short on a broad base; colour rich brown. (Text-fig. 16.)

Wings:—*Venation* brown at bases but soon becoming blackish; the wing calli and axillaries bright brown. *Pterostigma* 0·6 mm., rhombic, black, surmounting barely one cellule. *Postnodals* 12. M_2 arising 5 cellules distad from nodus, M_{1A} 2 cellules further distad.

♀. Unknown.

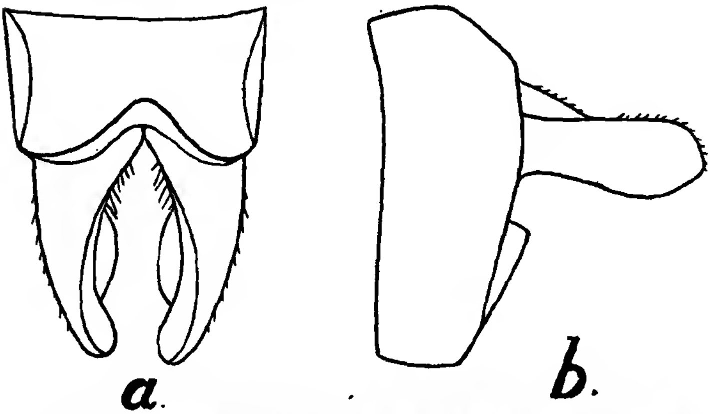


FIG. 16.—*Nesobasis campioni* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

Types:—Holotype male in Cawthron Institute Museum; also a single paratype male in British Museum Collection; both taken by Mr. Simmonds at Sigatoka, Viti Levu, Oct. 26th, 1922.

This species closely resembles *N. selysi* n. sp. at first sight, but can be at once distinguished from it by the sides of the synthorax being blue without any black bands, and by the shape of the appendages, which are of the same type as those of the much larger *N. longistyla* Selys.

15. Nesobasis aurantiaca n. sp.

(Text-fig. 17.)

♂. *Total length* 35, *abdomen* 28·5, *fore-wing* 18 mm.

Head:—*Eyes* dark brown, the orbits yellow in front. *Ocelli* transparent reddish brown. *Antennae* blackish, basal segment

orange. *Epicranium* and upper part of *frons* dark metallic green with small rectangular marks of reddish brown in front of and touching the median ocellus, similar marks in front of each antenna, and separate similar marks situated slightly mesad of each antenna; rest of *frons* orange; *postclypeus* black; *anteclypeus* and *labrum* orange; *gende* orange finely bordered with black in front. *Labium* dull yellowish.

Thorax:—*Prothorax* rich orange, the pronotum with two fine black points anteriorly, a fine mid-longitudinal black line, and a broader transverse black mark in front of the posterior lobe, which is moderately well angulated laterally. *Synthorax* rich metallic

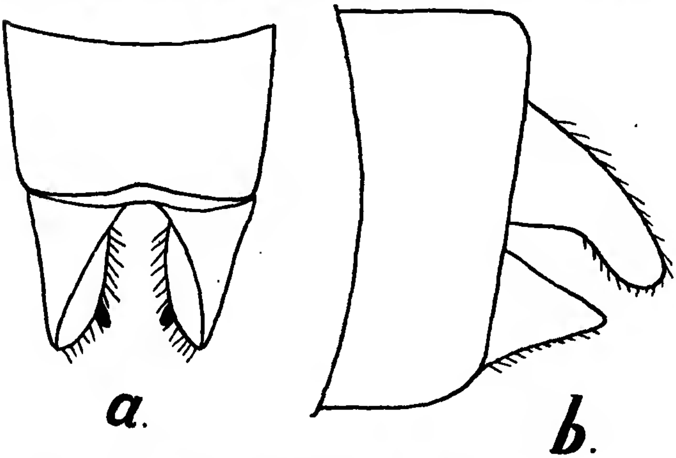


Fig. 17.—*Nesobasis aurantiaca* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

green above, with a triangular orange spot in front of the base of each fore-wing; sides and underside entirely dull orange except for a small blackish mark near base of each hind-wing. *Legs*:—coxae and hind femora dull orange, middle femora medium brown, fore femora dark brown; tibiae brownish; tarsi brown, shading to black distally on each segment; hairs black; claws black.

Abdomen:—Seg. 1 orange; seg. 2, orange with two basal black points and two larger apical rounded spots, united on each side by a fine longitudinal black line running very close to mid-dorsum; segs. 2–5 with an apical ring of black; segs. 3–8 dark metallic bronze green above, yellowish on sides and beneath; 3–6 with a narrow basal orange ring, interrupted mid-dorsally by black on 4–6. Segs. 9–10 blue above, yellow beneath. *Appendages*:—Superiors 0·3

mm., black, with brownish hairs; bases broad, fairly close together; shape subcornute, the inner portion strongly hollowed out; seen in profile, they are depressed, the apical half being strongly bent downwards. Inferiors 0·2 mm., broadly triangular in profile, the tips pointed and turned inwards. (Text-fig. 17.)

Wings hyaline with black *venation*. *Pterostigma* rhombic, 0·7 mm., dark brown, enclosed by black veins and surmounting one cellule. *Postnodals* 12–13. M_2 arising 6 cellules distad from nodus, M_{1A} three cellules further on.

♀. Unknown.

Types:—Holotype male in Cawthron Institute Collection; also two paratype males, one in British Museum

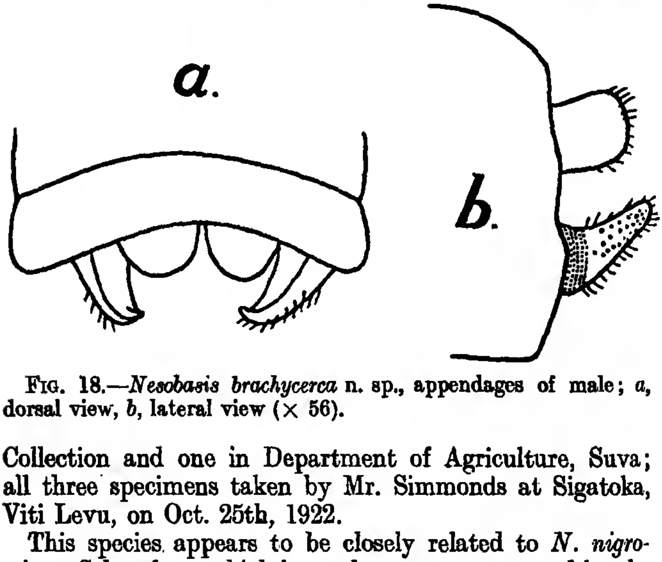


FIG. 18.—*Nesobasis brachycerca* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 56).

Collection and one in Department of Agriculture, Suva; all three specimens taken by Mr. Simmonds at Sigatoka, Viti Levu, on Oct. 25th, 1922.

This species appears to be closely related to *N. nigrostigma* Selys, from which it can be at once separated by the form of the appendages, by the angulated posterior lobe of the prothorax and by the smaller size and less number of postnodals.

16. **Nesobasis brachycerca** n. sp.

(Text-fig. 18).

♂. *Total length* 42, *abdomen* 35, *fore-wing* 23·5 mm.

Head entirely black, except *labium* and *orbits* beneath, which are yellowish.

Thorax:—*Prothorax* somewhat angulated postero-laterally, dark bronze green above, yellowish red on sides. *Synthorax* reddish on shoulders and sides, a broad band of dark bronze green situated dorsally; underside yellow. *Legs* yellow, with black spines.

Abdomen:—very slender, bronze black above, yellow below; seg. 9 mostly reddish above; seg. 10 entirely reddish. *Appendages* excessively short; superiors only 0·2 mm. long, dark, sub-cylindrical, bluntly rounded at tips; inferiors somewhat longer, reddish, subcornute, tips turned upwards and inwards. (Text-fig. 18.)

Wings:—*Pterostigma* 0·7 mm., rhomboidal, distal side somewhat convex; covering somewhat less than one cellule; blackish, circled with brown and enclosed with black veins. *Postnodals* 12–13. Only one cross-vein between origins of M_3 and Ms.

Type:—Holotype male, unique, taken at Bua, Fiji, on Sept. 9th, 1922, by Mr. Simmonds; in Cawthron Institute Collection.

17. **Nesobasis heteroneura** n. sp.

(Text-fig. 19.)

♂. *Total length* 34, *abdomen* 27, *fore-wing* 19 mm.

Head:—black, except *labrum*, which is bluish green, and a transverse anterior band on the frons, touching the eyes on either side, green; *eyes* brown above, green beneath; *labium* brownish.

Thorax:—*Prothorax* barely angulated postero-laterally, black above, blue on sides. *Synthorax* dark greenish black above, with a fine blue line in the humeral suture; sides blue, with a small black mark posteriorly in the second lateral suture; the blue extends upwards far enough to leave only a narrow dark band below the humeral suture. *Legs* black, except coxae, which are dull greyish.

Abdomen:—moderately slender and short, of about the build seen in *Ischnura* or *Pseudagrion*; general colour dark greenish black above. Segs. 1–2 broadly blue on sides. Segs. 9–10 bright blue above and on sides. Underside yellowish. *Appendages*:—Superiors 0·5 mm., blackish bordered with brown; seen from above they are subconical, with well-rounded apices; in profile they are rather broad, the apices well rounded; the apices carry strong hairs. Inferiors of same length, broadly sub-triangular, the tips with strongly hooked points turned inwards towards one another, only slightly hairy. (Text-fig. 19.)

Wings:—This species differs from all others of the genus in having the origins of M_3 and Ms placed further apart than usual, the distance between the two being either equal to, or a little more than,

the descending basal piece of Ms. *Pterostigma* 0·7 mm., rhomboidal, a little longer than wide, black circled with brown and enclosed by black veins; covering about one cellule. *Postnodals* 13–15; usually two, or even three, cross-veins between the origins of M_2 and M_{1A}, very exceptionally only one.

♀. *Total length* 31, *abdomen* 24, *fore-wing* 21 mm.

Differs from the male in being shorter and stouter, with the blue of the thorax replaced by yellowish; *abdomen* bronze black above, yellow on sides; no blue on segs. 1–2; segs. 9–10 either entirely bronze black above, or sometimes with a small blue blotch on 10 and distal part of 9. *Pterostigma* brown between black veins. *Legs* yellowish, shading to brown on tibiae and tarsi.

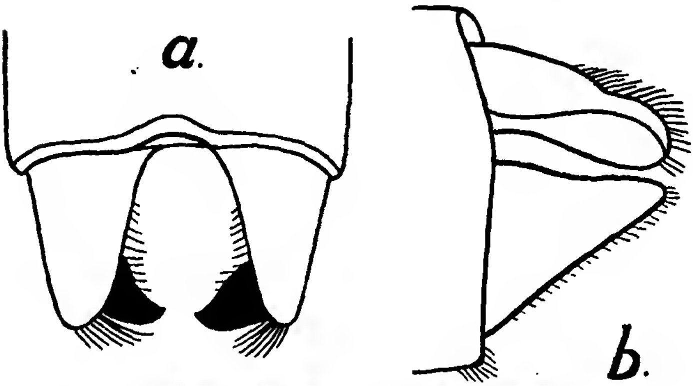


Fig. 19.—*Nesobasis heteroneura* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

Teneral forms of both sexes are pale yellow on those parts which become blue in the adult, while the colour of those parts which remain yellow in the adult is paler yellow. Aged females are almost entirely dull blackish, with grey pruinescence on sides of thorax.

Types:—Holotype male and allotype female, taken *in cop.*, Waidoi River, Aug. 29th, 1919, by Mr. Simmonds; in Cawthron Institute Collection. Also the following series of paratypes, taken during Aug. to Oct., 1919, in the same locality:—eleven pairs taken *in cop.*, seventeen adult single males, twelve adult single females, one teneral yellow male and three teneral yellow females.

This is at once the commonest and the least typical member of the genus *Nesobasis*. In general build and coloration it resembles, apart from its venation, a species

of *Ischnura*, such as the Australian *I. heterosticta* Burm. The more than usually wide separation of the points of origin of M_3 and Ms brings it close to the genus *Austroagrion*, from which it is at once separated by its larger size and lack of postocular spots, and also by the greater length of M_{1A} and Cu_2. In dichotomous keys of the genera of the group *Pseudagrion*, it would run down to the African genus *Argiagrion*, though almost certainly not truly related in any way to that genus, which contains the largest species in the whole series. I have thought it best to leave it at the end of the genus *Nesobasis*, while pointing out its obvious differences from the other members of that genus.

Genus Agriocnemis Selys.

Two species of this interesting little genus occur in the Fiji Islands. Both belong to the group in which the inferior appendages are much reduced, being represented merely by small tubercles carrying a minute black point. They may be distinguished as follows :—

Male with segs. 8–10 and apex of seg. 7 bright red; postocular spots of moderate size, sub-triangular . . . *A. vitiensis* n. sp.
Male with abdomen entirely black above, except for pale basal lines on segs. 3–6; postocular spots very small, broadly oval. *A. exsudans* Selys.

18. **Agriocnemis exsudans** Selys.

(Text-fig. 20.)

The type-locality for this species is New Caledonia, but I have also recorded it from the New Hebrides. Three specimens in the Simmonds Collection appear to be males of this species. The female has not previously been described.

The male has the *eyes* dark brown above, green beneath; the *epicranium* black, with a broad transverse band of white pulverulence extending between the forward part of the eyes, and including the bases of the antennae and the front margin of the median ocellus; *postocular spots* very small, broadly oval, dull orange; the *clypeus* is very dark purple, the *labrum* a deep metallic violet. *Thorax* blackish above, covered with whitish pulverulence; sides shading to greyish brown; breast more or less covered with white pulverulence. *Legs* with blackish femora and brownish-red tibiae and

tarsi; white pulverulence present ventrally on the femora in some cases. The *abdomen* is bronze black above, with pale yellowish basal lines around segs. 3–6; underside yellowish; appendages dull red. The shape of the *appendages* is shown in Text-fig. 20, though it should be noted that the abdomen was slightly turned so as to show a little more than half of the dorsal portion; *i. e.* the superior appendage is strictly not so far removed from the apparent mid-dorsal line of the last segment as the figure would indicate.

The New Hebrides specimens have a large dark patch on the superior appendages, which is absent in the Fijian specimens. De Selys does not state definitely what colour the superior appendages are in the New Caledonian types, though one might assume that they were reddish, from his reference to the resemblance

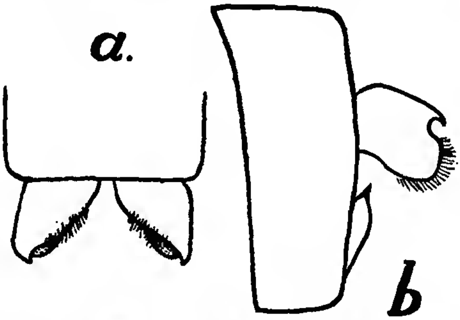


FIG. 20.—*Agriocnemis exsudans* Selys, appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

between this species and *A. pygmaea* Ramb., which has them reddish also. *Postnodals* 5–7, usually 7. *Pterostigma* 0·5 mm., brownish in fore-wing, black in hind-wing, covering somewhat less than one cellule.

Two females which appear to belong to this species, though not taken *in cop.*, differ from the males in the absence of the white pulverulence, the shiny black labrum, the large triangular post-ocular spots of a yellowish colour, the thorax bronze black above, bronze yellow on sides, shading below to livid, the legs dull greyish brown with blackish bands above on femora, and black apices to the segments of the tarsi. The abdomen is coloured much as in the male, but is slightly shorter and stouter, more cylindrical. Appendages very short, conical, reddish. Sutures between segs. 7–10, pale yellowish. Pterostigma pale brownish on all four wings.

Types :—Holotype males from New Caledonia in Coll.

Selys, Brussels Museum. Allotype female and one paratype female, Waidoi River, Fiji; taken by Mr. Simmonds, the former on June 2nd, 1919, the latter on Sept. 7th, 1919; three males taken from same locality on Sept. 8th, Sept. 17th and Oct. 2nd, respectively. Allotype female in Cawthron Institute Collection, paratype female in British Museum Collections; one male in each of these Collections and one in Dominion Museum, Wellington, N.Z.

19. **Agriocnemis vitiensis** n. sp.

(Text-fig. 21.)

This species belongs to the same group as the above, having appendages closely similar to it in form and also the labrum of a rich metallic violet.

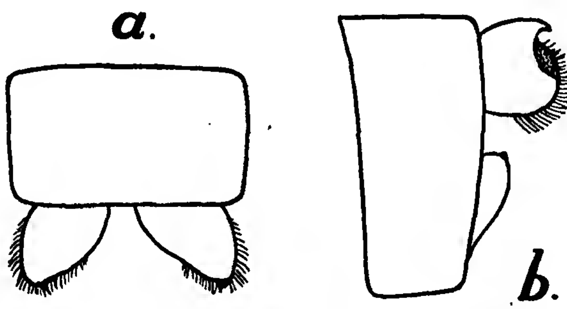


Fig. 21.—*Agriocnemis vitiensis* n. sp., appendages of male; *a*, dorsal view, *b*, lateral view (× 45).

♂. *Total length* 26·5, *abdomen* 21, *fore-wing* 12 mm.

Head:—*Eyes* purplish black above, green beneath. *Postocular spots* of moderate size, sub-triangular, green. *Epicranium, frons* and *postclypeus* black; *anteclypeus* and *cheeks* pale yellow; *labrum* rich metallic violet; *labium* and *orbits* beneath pale testaceous.

Thorax:—*Prothorax* bronze black above, pale greenish on sides. *Synthorax* bronze black above, with a yellow humeral line, sides pale greenish. *Legs* dull brownish, darker at apices of femora, and with the apices of the tarsal segments black.

Abdomen:—Segs. 1–6 bronze black above, yellow below, with a fine yellow line around bases of 2–6; seg. 7 mostly bronze black above, but apical sixth red, the red colour extending further basad on the sides; segs. 8–10 and appendages entirely bright red.

Appendages as shown in Text-fig. 21, the superiors somewhat broader than those of the preceding species both in dorsal and lateral view, the inferiors represented only by a reddish tubercle carrying a fine black point.

Wings:—*Pterostigma* 0·6 mm., trapezoidal, anterior side longer than posterior, covering considerably less than a single cellule; colour pale brown with darker centre, the whole enclosed in black venation, and that of hind-wing darker than that of fore-wing. *Postnodals* 7.

♀. *Total length* 26·5, *abdomen* 21, *fore-wing* 14·5 mm.

Very different in coloration from the male.

Head:—*Eyes* black above, green beneath. *Postocular spots* very large, sub-triangular, reddish orange. *Epicranium* black; on the *frons*, a narrow transverse line of red, divided medially by a black longitudinal bar, and spreading out laterally very widely on the anterior part of the orbit. *Postclypeus* blackish; *anteclypeus* and *labrum* brown. *Labium* pale testaceous.

Thorax:—*Prothorax* red above, with a black T-mark, the cross-bar of which is fine and clear, but the stem duller and more diffuse, spreading out in the form of a triangle with its base on the posterior margin of the segment. *Synthorax* with broad dorsal band of bronze black, followed by an antehumeral band of deep yellow on either side; sides red above, shading to greenish yellow below, with slight tinges of red. *Legs* pale yellowish brown.

Abdomen:—red above, yellow beneath; last third of seg. 6, the whole of segs. 7–8, most of seg. 9 and a basal patch on seg. 10, blackish. *Appendages* exceedingly short, reddish. *Ovipositor* yellowish.

Wings:—*Pterostigma* 0·7 mm., trapezoidal, with the posterior side considerably shorter than the anterior, covering less than one cellule; colour pale brown between black veins on all four wings. *Postnodals* 7–9.

Types:—Holotype male (Oct. 10th, 1919) and allotype female (Aug. 31st, 1919), taken by Mr. Simmonds on Waidoi Plantation; in Cawthron Institute Collection; also a series of five paratype males and two paratype females, one pair being in British Museum Collections, the other in the Dominion Museum, Wellington, N.Z.

A single aged male in this collection has the thorax well covered with greyish pruinescence while keeping the red colour of the end of the abdomen quite vividly.

Genus Ischnura Charp.

20. **Ischnura heterosticta** Gurm.

One male and one female taken by Mr. Simmonds at Sigatoka, Viti Levu, Oct. 30th, 1922. Mr. Campion has also noted this species in material sent for determination from Fiji by Mr. Robert Veitch in 1916.

21. **Ischnura aurora** Br.

Three males and two females of this beautiful little species are included in the collection, all from Waidoi Plantation, Aug. and Sept., 1919.

Sub-order *ANISOPTERA*.

Family AESCHNIDAE.

Genus Anaciaeschna Selys.

22. **Anaciaeschna jaspidea** (Burm.).

A single male of this species was taken at Waidoi Plantation by Mr. Simmonds on June 2nd, 1919.

Family LIBELLULIDAE.

Sub-family *CORDULIINAE*.

Genus Synthemis Selys.

23. **Synthemis macrostigma macrostigma** Selys.

Not represented in the Simmonds Collection. The type female, in the Hagen Collection, was taken in Fiji; the type male is labelled " Oceania," and may also have come from Fiji. The species is abundant on mountain swamps in Eastern Australia, where it forms a distinct subspecies, *S. macrostigma orientalis* Till. It also occurs in Western Australia, at lower elevations, as a third subspecies, *S. macrostigma occidentalis* Till. The genus is confined to Australia, Tasmania, Papua, New Caledonia and Fiji.

Genus Procordulia Martin.

24. **Procordulia irregularis** Martin.

This fine and rare species is represented by a single male and three females in the Simmonds Collection. These

were taken on the mountains around Waidoi by Mr. Simmonds, the male on Aug. 6th, 1919, the females on Aug. 31st, Sept. 6th and Sept. 12th, respectively. The male and one female are in the Cawthron Collection, a second female in the British Museum Collections, and the third in the Dominion Museum, Wellington.

Genus HEMICORDULIA Selys.

25. **Hemicordulia tau** Selys.

Not represented in the Simmonds Collection, but recorded by Selys in Bull. Acad. Belg. (2), xxxi, (1871), p. 257, from "îles Fidji (Coll. Hagen)."

Sub-family *LIBELLULINAE.*

Genus HYPOTHEMIS Karsch.

This monotypic genus is placed by Ris as the most primitive representative of the sub-family; the single species is confined to Fiji.

26. **Hypothemis hageni** Karsch.

Not represented in the Simmonds Collection. It appears to be very rare, but is probably easily overlooked owing to its small size.

Genus ORTHETRUM Newm.

27. **Orthetrum sabina** (Drury).

A single female of this widely spread species was taken by Mr. Simmonds on Waidoi Plantation, June 19th, 1919. It is in the Dominion Museum, Wellington. Also recorded by Ris from Fiji (Monograph. Libellulinen, p. 224).

Genus LATHRECISTA Kirby.

28. **Lathrecista asiatica asiatica** Fabr.

Not represented in the Simmonds Collection. This species is widely distributed from Borneo and Celebes right through to Fiji and Tonga. Ris records a male from Fiji in the British Museum Collections (Monograph. Libellulinen, p. 130).

Genus Diplacodes Kirby.

29. **Diplacodes bipunctata** (Brauer).

A single male of this common species is included in the Simmonds Collection by coloured drawing only, undated. Mr. Simmonds wrote that it was a sketch of an individual of a "rather common" species. There was no difficulty in recognising the species from the drawing. There is also a male of this species in the Selys Collection in the Brussels Museum, and one male and two females in the Hamburg Museum, as recorded by Ris (Monograph. Libellulinen, p. 471). It is abundant throughout Australia, and not uncommon in the North Island of New Zealand, though much rarer in the South Island.

30. **Diplacodes trivialis** (Ramb.).

Not represented in the Simmonds Collection. A common species ranging from India through the Malay Archipelago to Papua and Queensland. It is recorded from Fiji by Ris (Monograph. Libellulinen, p. 469), and Mr. Herbert Campion informs me that he has also seen material of this species from Fiji.

Genus Pantala Hagen.

31. **Pantala flavescens** (Fabr.).

Not included in the Simmonds Collection, but recorded from Fiji by Ris, specimens from these islands being present in the Hamburg Museum. It appears to be present on all the tropical and subtropical islands of the Pacific.

Genus Tramea Hagen.

32. **Tramea limbata** (Desjardins).

Not present in the Simmonds Collection. Recorded from Fiji under the name *T. transmarina* Brauer.

Genus Rhyothemis Hagen.

33. **Rhyothemis phyllis dispar** Brauer.

This is a very distinct subspecies of the widely spread *Rh. phyllis* (Sulz.), and is confined to the Fiji Islands. It can be at once recognised by the dark band along the whole of the costa, spreading out widely around the apex, in both sexes; the wings of the female are more heavily

marked than those of the male. The Simmonds Collection contains a male taken by Mr. Simmonds on Aug. 22nd, 1919, and a female on Sept. 15th, 1919, both on Waidoi Plantation. The male is in the British Museum Collections, the female in the Dominion Museum, Wellington.

Besides the above specimens, Mr. Simmonds sent two rather young larvae in spirits, taken from the Waidoi River. These have rather broad, horizontally placed caudal gills, and appear to belong either to the genus *Argiolestes* or possibly to its close relative *Trineuragrion*. We may therefore hope that representatives of the ancient Megapodagrioninae may one day be taken in Fiji, affording yet further proof of its being an outlying portion of the ancient Australian land-mass.

An Analysis of the Zoo-Geographical Elements composing the Odonate Fauna of the Fijian Islands.

Our knowledge of the Odonate fauna of Fiji appears to be now sufficiently complete to allow of an analysis being made of the various elements which enter into its composition from the zoo-geographical standpoint. We may ask, is the fauna a purely insular one, or is it an offshoot from a true continental fauna; and, if the latter, then to what zoo-geographical region does it belong? In order to answer these questions, we must first analyse the components of the fauna with a view to discovering which are the endemic forms, and also which forms belong to the various divisions of the zoo-geographical regions concerned. The results obtained are as follows :—

A. Endemic Genera :—In this division we must include *Nesobasis* with fifteen species and *Hypothemis* with one species only. *Nesobasis* is reckoned as endemic in spite of the existence of a single Papuan species (*N. ciliata* Ris) placed by Dr. Ris in this genus, since it seems clear that the Papuan species stands well apart from the Fijian group of species, and ought perhaps to be placed in a distinct genus.

Nesobasis is allied on the one hand to *Teinobasis* Kby. and on the other to *Pseudagrion* Selys. It is clearly more archaic than either of these genera; than *Teinobasis*, because of the less petiolate wings and the unreduced tarsal

claws; than *Pseudagrion*, because of the absence of post-ocular spots, the simple prothorax of the female, and the less specialised form of the appendages. It may well represent fairly closely the original type from which the groups Teinobasini and Pseudagrionini have arisen, and is certainly to be reckoned an archaic genus compared with most of the genera found within these two tribes.

Hypothemis is a monotypic genus placed by Ris at the very base of the sub-family Libellulinae. It is closely allied to *Tetrathemis*, a genus of wide distribution from West Africa through India and the Malay Archipelago to Australia, and also appears to lie close to the base of the original stem of the Eucorduliine group of the sub-family Corduliinae, as represented by *Cordulephya* at the present day.

We see then that these two endemic genera have several points in common. They are both distinctly archaic as compared with their nearest allied genera; they both stand within their own tribes at a point very close to the original of another tribe (*Nesobasis* in Pseudagrionini close to origin of Teinobasini, *Hypothemis* in Tetrathemini close to the origin of Cordulephyini); and they both belong to old complexes of forms having a distribution from Africa through India and Malaya to the Australian Region (*e. g.* the dominant genera *Pseudagrion* on the one hand and *Tetrathemis* on the other). Such a distribution suggests an origin in late Gondwana-land, and could be readily understood if we were to accept Wegener's theory of the drift of continental masses. In any case, it indicates an origin not later than Jurassic for these two complexes, and would point to the fact that, about this time, the Fijian Islands formed a portion of the old continental mass bordering the Pacific Ocean on the west, whose original shore is now sundered from Australia by the great Tasman Sea. That this was so, we know already from evidence furnished by the geology of the Islands themselves.

B. Endemic Species of Non-endemic Genera :—Under this heading we group the four species *Austrolestes vitiensis* n. sp., *Pseudagrion pacificum* n. sp., *Agriocnemis vitiensis* n. sp. and *Procordulia irregularis* Martin (the record given by Martin for this last species from "Celebes" is surely an error). Two of these belong to genera (*Pseudagrion, Agriocnemis*) having a closely similar distribution to those given in Section A, while *Procordulia* ranges from

Australia and New Zealand through to Java, and *Austrolestes* is an Australian complex within the almost world-wide group of forms comprised in the great genus *Lestes*.

All the above must be reckoned as later additions to the Fijian fauna than those given in Section A. They probably reached the Islands about the period when they were being severed for the last time from their continental connection. The Zygoptera represented in this Section B may well have made little headway after their arrival owing to the fact that *Nesobasis* had already become dominant, and the new arrivals were not strong enough to compete with it to any extent.

C. Endemic Subspecies of Non-endemic Species :—Under this heading we have *Synthemis macrostigma macrostigma* Selys and *Rhyothemis phyllis dispar* Br. The former is much more archaic than the latter, and must be reckoned as a much older element in the Fijian fauna, seeing that, at the present time, the species *S. macrostigma* Selys is represented by three widely separated subspecies, in Western Australia, Eastern Australia and Fiji, respectively. Being a weak-flying species confined to mountain swamps, it must have reached Fiji before the old continental connection was finally severed. *Rhyothemis phyllis dispar*, on the other hand, may well be quite a late addition to the fauna, as it belongs to a highly evolved and dominant genus having a wide distribution from Africa to Australia, and is a subspecies of a species, *Rh. phyllis* Kby., which shows a continuous distribution right through from India to Australia and Fiji.

D. Non-endemic Species :—There remain twelve species belonging to ten genera which may be included under this heading. They can be classified as follows :—

D 1. Austro-Malayan Species :—*Ischnura aurora* Br., *Anaciaeschna jaspidea* (Burm.), *Lathrecista asiatica* (Fabr.), *Orthetrum sabina* (Drury), *Diplacodes trivialis* (Ramb.) and *Tramea limbata* (Desj.). Of these, the oldest of the Libellulinae is undoubtedly *Lathrecista asiatica*, which is the only one in which two distinct subspecies have been evolved during the passage from Papua to Australia on the one hand, and from Papua to Fiji and Tonga on the other. As it is a species which haunts the deep jungle and flies but little, it probably reached Fiji while there was still a fairly easy way of entry by means of a continuous land-bridge or close chains of islands. The same may be true

of *I. aurora* Br., which is a very weak flier, but might conceivably be carried by wind storms. The other four species are almost certainly late arrivals which could readily pass over considerable stretches of water from island to island.

D 2. Australian Species :—*Ischnura heterosticta* Burm., *Diplacodes bipunctata* (Br.) and *Hemicordulia tau* Selys. These may be considered as late additions to the fauna, all being very common in Eastern Australia. *Hemicordulia tau* has been observed migrating, and has probably colonised Fiji directly from Australia. The other two probably spread more slowly from island to island after the continental connection was finally broken.

D 3.—New Caledonian Species :—*Agriocnemis exsudans* Selys is found only in New Caledonia and Fiji, and appears to be a fairly old species which perhaps developed as common to the two groups of islands when they were much more closely connected than they are at the present time. The fact that the other Fijian species of this genus is endemic would tend to support this view.

D 4. Circumtropical Species :—A single species, the ubiquitous *Pantala flavescens* (Fabr.). It is a fine flier with a strong migratory instinct, and is evidently a very late addition to the fauna of the Islands. This species is still in process of colonizing the eastern coastline of Australia, where it has already reached a point somewhat south of Sydney.

The above results may be exhibited numerically as follows :—

ANALYSIS OF THE GENERA OF ODONATA IN FIJI.

Distribution.	Number.		Percentage of whole fauna.	
Endemic	2		12·5	
Non-endemic :—	14		87·5	
Australian		2		12·5
Austro-Malayan		4		25·0
Late Gondwanan (= *Africo-Malayan*)		6		37·5
Circum-tropical		2		12·5
Total	16		100·0	

ANALYSIS OF THE SPECIES OF ODONATA IN FIJI.

Distribution.	Number.		Percentage of whole fauna.	
Endemic species	20		60·6	
Additional endemic subspecies	2		6·1	
Non-endemic :—	11		33·3	
New Caledonian		1		3·0
Australian		3		9·1
Austro-Malayan		6		18·2
Circum-tropical		1		3·0
Total	33		100·0	

XVIII. *The Genitalia in* Sabatinca *and Allied Genera (Lepidoptera Homoneura), with some Observations on the same Structures in the Mecoptera.* By ALFRED PHILPOTT, Assistant Entomologist, Cawthron Institute, Nelson, N.Z.

[Read October 17th, 1923.]

(WITH TWENTY-ONE TEXT-FIGURES.)

BY common consent the Micropterygidae are regarded as the most primitive of the Lepidoptera, and *Sabatinca* is generally admitted to be the most archaic genus of the family. What chiefly strikes the student of the genitalia in this genus is the apparent absence of the eighth sternite and the simplicity of the parts as compared with those of the higher Lepidoptera. The complicated tegumen and uncus, the intricate valvae with their varied armature and the puzzling parts of the anal segment are replaced by much simpler structures. But, unfortunately, this simplicity

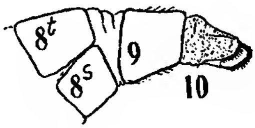


FIG. 1.—*Sabatinca aurella* Huds. ♀.

appears to be the result rather of specialisation than the retention of primitive characters, consequently, less information than might be expected is to be gained from the investigation. Still, such an investigation is full of interest and certain conclusions, though perhaps of only minor value, emerge therefrom.

A detailed account of the parts now follows; but it has been thought advisable to refrain from any attempt to give a minute description of the structures in writing, and to trust more to figures to convey the correct impression to the reader. The genus *Sabatinca* will first be dealt with, and I have been fortunate enough to have at my dis-

posal specimens of thirteen out of the fourteen New Zealand species, as well as one Australian form. *Sabatinca demissa* Philp. has had to be left out of the inquiry, the male of that species not being yet known. Such other genera as I have been able to obtain material of will then be examined, and in conclusion some of the questions arising as a result of the study will be discussed.

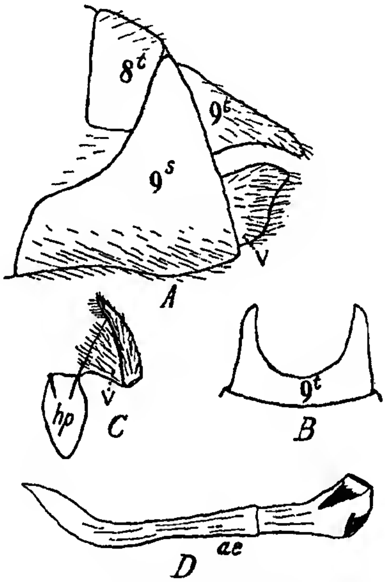


Fig. 2.—*Sabatinca lucilia* Clarke, ♂.

Sabatinca : *the Eighth Sternite.*

A consideration of the eighth segment is not usually necessary in discussing the genitalia of the Lepidoptera, but in this case, as the segment is greatly modified, and as this modification is apparently directly connected with the genital parts proper, it follows that it must be taken into account.

As has already been noted, the eighth sternite is completely absent in the males of *Sabatinca*, though present and normal in the females. When the much-enlarged ninth sternite is taken into consideration it might be thought

that the eighth and ninth sternites had become fused into one large piece, but when *Micropteryx* (Fig. 14A) is examined

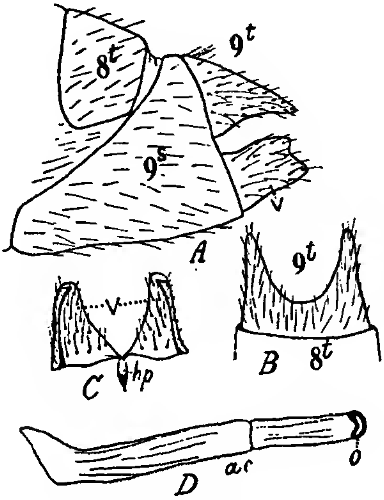


FIG. 3.—*Sabatinca calliarcha* Meyr. ♂.

it is found that the eighth sternite is still represented by a thin chitinous strip, showing that atrophy, and not fusion,

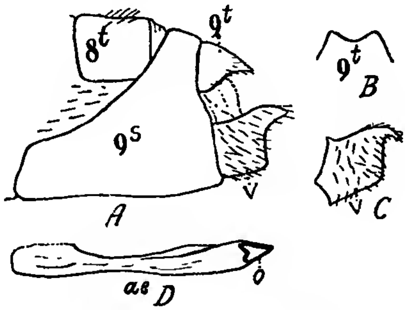


FIG. 4.—*Sabatinca eodora* Meyr. ♂.

has been responsible for the loss. Probably the course taken in *Sabatinca* was the complete dechitinisation of the eighth sternite followed by the extension basad of the ninth.

The Ninth Sternite.

In the higher Lepidoptera, what is usually considered to be the ninth segment has undergone extreme modification, generally by narrowing. It also usually occupies a more or less oblique position, the sternite, or the greater part of it, passing within the preceding segment. The tergite is often produced above into an elongate hook (the uncus), curving downwards and generally armed with hairs or spines. Thus modified, the whole segment is

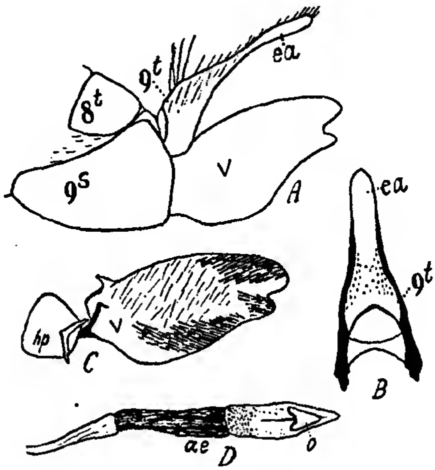


FIG. 5.—*Sabatinca ianthina* Philp. ♂.

known as the tegumen. In *Sabatinca* the ninth sternite is greatly enlarged, extending right beneath the eighth tergite (Figs. 4A, 5A, etc.). It is very strongly chitinised and is produced upwards distally as an arm or prong, usually reaching the dorsal surface of the abdomen (Fig. 10A); in some species these arms meet and become fused, thus forming a completely chitinised ring encircling the abdomen. The species with this complete ring are *calliarcha*, *eodora* and

* For the purposes of this study it will be assumed that the part known as the tegumen in the higher Lepidoptera consists of the ninth sternite and ninth tergite. That this is the true interpretation of the parts may not be absolutely certain, but it seems a quite reasonable enough conclusion to work on.

ianthina (Figs. 3, 4 and 5), the last having a weak chitinisation only. In the others all degrees of modification are to be found, from *zonodoxa* (Fig. 12), with but little upward production of the sternite, to *doroxena* (Fig. 7), where the prongs almost meet across the back of the abdomen. The condition of the ninth sternite does not seem, however, to be correlated with any other structural feature; it could

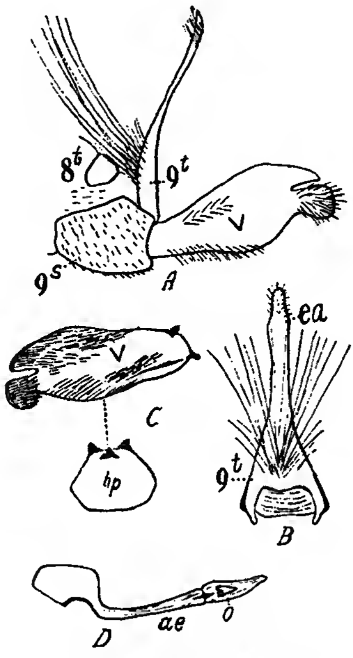


Fig. 6.—*Sabatinca aurella* Huds. ♂.

not be used, except artificially, to subdivide the genus, and to attempt to so use it would mean the separation of two such obviously related forms as *lucilia* and *calliarcha*.

The Ninth Tergite.

The ninth tergite (or dorsal half of the tegumen) is a more or less hood-shaped structure. It is membranously attached to the ninth sternite, and is freely movable in so far as this hinge allows. Usually it is directed obliquely

upward, but in *eodora*, *lucilia* and *calliarcha* the direction is obliquely downward (Figs. 2A, 3A and 4A). These three species agree also in having the apex of the tergite excised, slightly in the first, and so broadly and deeply in the two latter as to divide the structure into two lateral forks or lobes, the surgonopods or surstyli of some authors (Figs. 2B, 3B and 4B). In *ianthina*, *aurella* and *doroxena* the

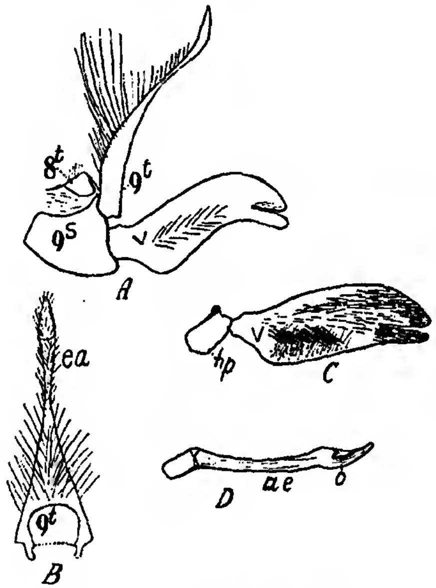


FIG. 7.—*Sabatinca doroxena* (Meyr.). ♂.

ninth tergite is extraordinarily lengthened, being drawn out apically into a long tapering organ (Figs. 5B, 6B and 7B). This is the nearest approach to an uncus, as far as I have been able to ascertain, in the Micropterygidae, and it seems probable that this structure, so common in the higher Lepidoptera, arose from the curving downwards of the apex of the tergite in some form in which the organ had become elongated, as in *ianthina* and its related species. In *chrysargyra*, *quadrijuga*, *incongruella*, *caustica* and *barbarica* (Figs. 8A, 9A, 10A and 11A; ventral and dorsal views, Figs. 8B, 9B, 10B and 11B) the tergite is short, broad and typically hood-shaped, while in *zonodoxa* (Figs. 12A and

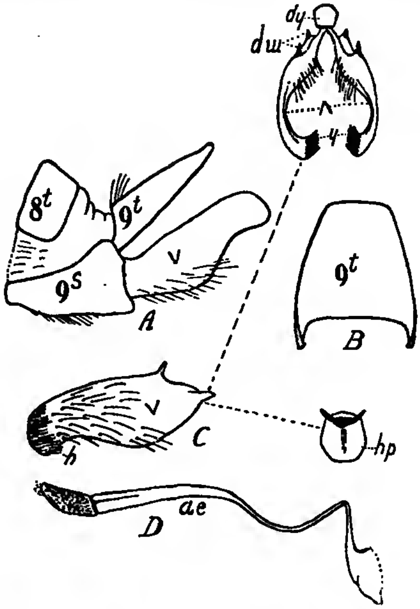


Fig. 8.—*Sabatinca chrysargyra* (Meyr.). ♂.

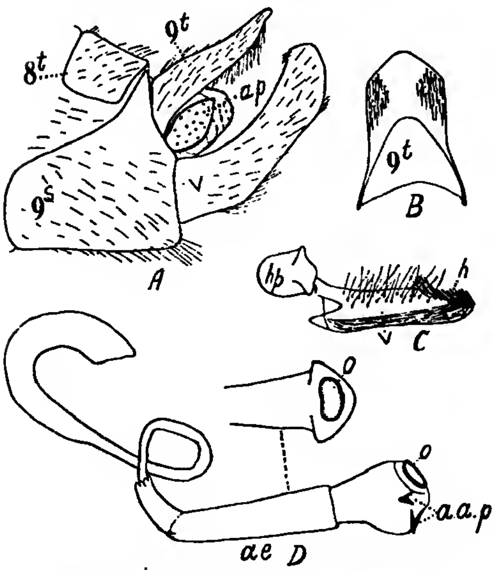


Fig. 9. —*Sabatinca quadrijuga* Meyr. ♂.

12B) and *rosicoma* the shape is much the same, but with a small central process at the apex.

The dorsal surface of the tergite is generally sparsely clothed with hairs of moderate length, but in those species having the apical part much lengthened (*ianthina*, *aurella* and *doroxena*) there are a number of very long hairs situated on the broader area near the base (Figs. 5A, 6A and 7A). On the lower surface of this type of tergite there is no armature, nor is there anything special in the group with the excised apex (*lucilia*, etc.), but where the tergite is of the rounded hood-shaped kind there is usually on each side towards the apex a number of long, stiff, backwardly-directed hairs (Figs. 10B and 11B). In *chrysargyra*, however, this armature is absent.

The Anal Sclerites.

The consideration of the anal area does not really come under the head of genitalia study, but it is convenient to refer here to the structures. The anal opening is situated

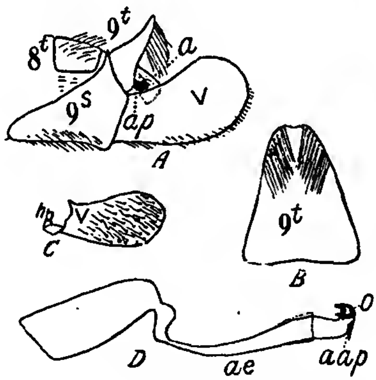


FIG. 10.—*Sabatinca incongruella* Walk. ♂.

between the lateral basal angles of the ninth tergite. It is protuberant, and on each side of it lies a chitinised plate similar to that found in many other groups of insects (Figs. 9A and 10A). These plates have been considered to represent parts of the tenth tergite. In the species of *Sabatinca* these vestigial structures exhibit considerable difference in point of size, ranging from the very small

ones of *ianthina* and *aurella* to the large and strongly chitinised ones of *quadrijuga* and *caustica*.

The Valvae.

The valvae (also known as genital styles, gonostyli, gonopods, etc., and by the older Trichopterists as the inferior appendages) are, in the Micropterygidae, of fairly simple form and structure. It is interesting to note that they fall into groups correlated with the form of the ninth

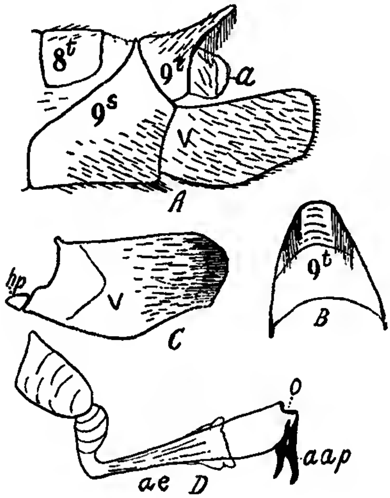
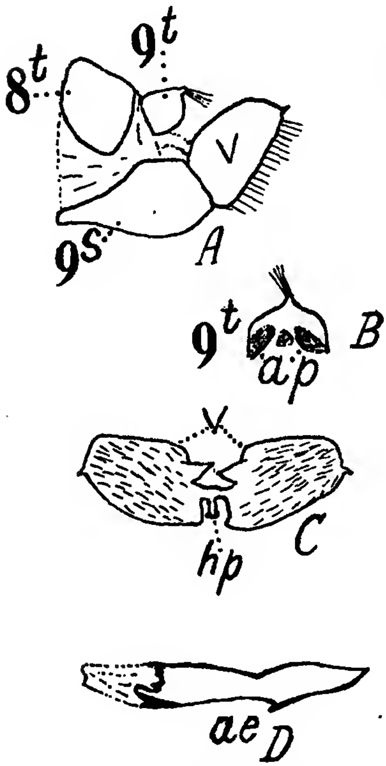


Fig. 11.—*Sabatinca barbarica* Philp. ♂.

tergite. In those species which have the tergite narrowed and elongated the valvae are also elongate, and agree in having the apex divided by a cleft into two lobes (Figs. 5c, 6c and 7c), the size and shape of which clearly differentiates the species. The harpes, or armature of the inner surfaces, consist of rather thick blunt spines, the area covered by which can be seen by reference to the figures. In the groups with the excised apex of the tergite (*lucilia* and its allies) the valvae are short and broad and the harpes are absent, the inner surface being clothed with weak hairs only (Figs. 2c, 3c and 4c). Those species with the hood-shaped ninth tergite have the valvae longer in proportion

than the preceding group, the harpes consisting of rather short but stout spines round the apex, followed by finer hair towards the base. In *zonodoxa* (Fig. 12) and *rosicoma* the ninth tergite is unusually small, the valvae being about



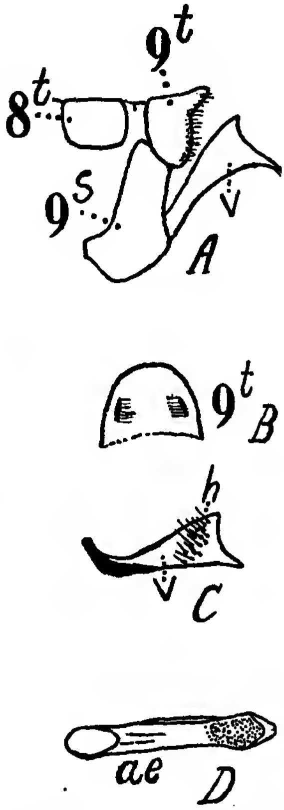


FIG. 12.—*Sabatinca zonodoxa* (Meyr.). ♂.

FIG. 13.—*Sabatinca calliplaca* Meyr. ♂.

three times as large; there is a minute inwardly curved spur at the apex and the inner surface is clothed with hair, no true harpes being present. The Australian *calliplaca* (Fig. 13) stands in some degree apart from the New Zealand species. The ninth tergite in this form is hood-shaped, but the valvae are narrow basally, expanding

to a truncate apex where the points end in two inwardly curved prongs. The harpes consist of a band of rather stout spines set in a transverse area some distance below the apex.

The valvae are united at their bases by a horizontal plate which varies in size and shape according to the species (Figs. 3c, 7c and 8c). Under normal conditions this plate and the bases of the valvae lie within the ninth sternite. Freshly killed material has not been available for the purpose of this paper, but the examination of even dried specimens, after maceration in a ten per cent. solution of KOH, gave some hint of the probable method of functioning

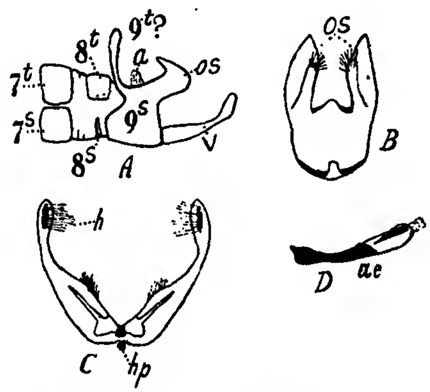


FIG. 14.—*Micropteryx aruncella* (Scop.). ♂.

of the parts. On the valvae being opened by force it was seen that their bases, with the horizontal plate, were drawn forwards to the edge of the sternite, the tergite being at the same time raised; on the valvae being closed the process was reversed. No doubt, in life, the movements are effected by muscular action, and near the base of the valva, on the lower margin, there is a well-chitinised conical projection, apparently a process for the attachment of muscles. A little distad of this, and on the upper outer part, is a similar, but usually longer, projection ending in a point which engages a projection from the lateral basal angle of the tergite. There is thus little dependence of the valvae on the ninth tergite, merely that due to the passing of the valvae through the membrane which closes the end of the abdomen.

The Aedeagus.

The aedeagus invariably shows characters of specific value, but for the consideration of these the reader is referred to the figures. It may be pointed out that the organ almost always belongs to one of two types; either the penis is apically pointed and without armature (Figs. 4D, 5D, etc.) or it is more or less rounded and armed with one or more pairs of chitinised projections (Figs. 10D and 11D). Attention may also be called to the general resemblance of the organ in *ianthina*, *aurella* and *doroxena*, three

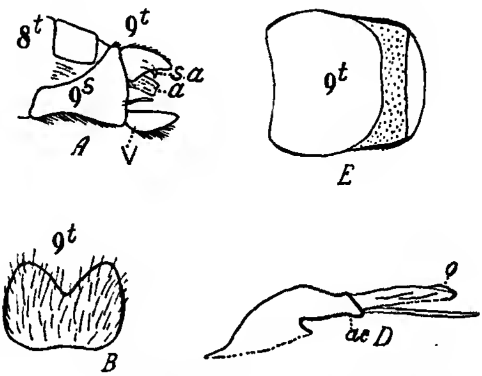


FIG. 15.—*Epimartyria auricrinella* Wlsm. ♂.

closely related but sufficiently distinct forms which have been shown to possess other genital characters in common. The orifice of the penis is more or less reniform and the margin is pleated or finely corrugated (Fig. 9D). The figures of the aedeagus, being taken from macerated dry material are, in all probability, as the organ is for the most part but slightly chitinised, not exact in minor details, but the general type of structure is no doubt sufficiently accurate for comparison.

The Female Genitalia.

The tenth segment in the females of *Sabatinca* is, when at rest, completely withdrawn within the ninth. It is divided apically into two lateral lobes (Fig. 1), and there

seems to be extremely little difference between the various species. It is difficult to believe that the extraordinary variation in the genitalia of the males has anything to do with the structure of the genital segments in the corresponding females of the species.

The Status of **S. rosicoma** *Meyr. and* **S. barbarica** *Philp.*

In working through the species of *Sabatinca* it was found that the male genitalia of *S. rosicoma* Meyr. did not

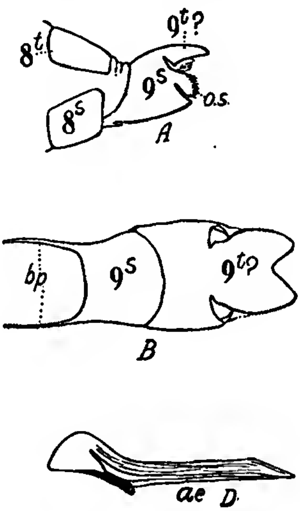


FIG. 16.—*Mnemonica auricyanea* (Wlsm.). ♂.

exhibit any differences from those of *S. zonodoxa* Meyr., and the same has to be observed of *S. barbarica* Philp. and *S. caustica* Meyr. But it is not proposed to unite these two pairs of species. It is, of course, obvious that forms which cannot be separated by genital characters are very closely related, and it is possible that *rosicoma* is best regarded as a subspecies, or race, of *zonodoxa*, and that a similar relationship exists between *caustica* and *barbarica*. With regard to the former pair there seem to be definite and constant differences in the wing markings, and this is true also, though in less degree, of the latter pair. So far, all the species appear to have been found in separate

localities, no instance of any two of them being found together having been recorded. Certain small differences may be noted in the venation, and it is possible that constant though very minute variations may exist in the genitalia. To ascertain this, however, it would be necessary to examine long series, and none of the species appears to be abundant. Having regard to all these considerations it seems advisable, for the present, to allow each form to retain specific rank.

Micropteryx.

The only species of this genus which I have been able to examine is *Micropteryx aruncella* Scop. In this form the eighth sternite has not quite disappeared; it still persists as a very narrow strip (Fig. 14A). The ninth tergite offers a puzzling problem. Its lower half is similar in shape to

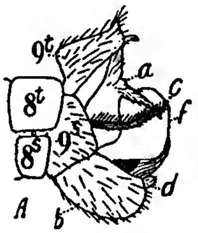


FIG. 17.—*Bittacus punctiger* Westw. ♂.

that of *Sabatinca*, but the upper portion is produced into a narrow piece, occupying a more erect position than the ninth tergite in *Sabatinca*. Beneath this on each side there is what appears to be a secondary clasping apparatus, consisting of a thin outer plate curved upward apically into a point and folding inward beneath so as partly to embrace an inner blunt process with a brush of hair on its apex (Fig. 14A and B). Structures of this kind, when outgrowths of the ninth tergite, have been called surgonopods or surstyli, but it is doubtful if the present pieces belong to the tergite. There is no indication of the fusion of the ninth sternite and tergite, and it seems most probable that the tergite has disappeared entirely, its place being taken and its functions carried out, by outgrowths from the sternite. The lateral anal plates are well chitinised. The valvae (Fig. 14C) have the sides folded in basally, and an elongate central area on the inner surfaces of the apices

is clothed with rather long hair. The horizontal plate is minute.

Epimartyria.

Specimens of *E. auricrinella* Wlsm. have been available for study. In this species the eighth sternite is missing. The ninth sternite completely encircles the abdomen as a strongly chitinised band (Fig. 15E). The ninth tergite is short but deeply concave beneath. The apex is rather deeply excised, and firmly attached to the inner surface is a complicated chitinous structure, from which two claw-like hooks point downwards and obliquely outwards. The anal tube lies beneath these hooks. The valvae are short and broad and the genitalia and genital segments are, in most respects, nearer to *Sabatinca* than is *Micropteryx*.

Mnemonica.

I have not been able to examine more than one species of the family Eriocraniidae. This is the North American

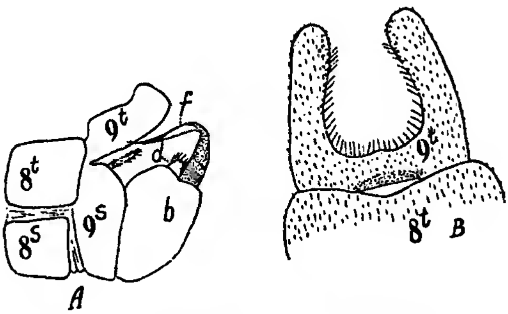


FIG. 18.—*Harpobittacus australis* (Klug). ♂.

Mnemonica auricyanea Wlsm. Here the eighth sternite is quite normal, but the ninth has undergone extraordinary modification (Fig. 16B). As in *Epimartyria auricrinella* the sclerite forms a complete band round the abdomen, but in *auricyanea* the band is much broader. Beneath, the segment is produced into a long prong on each side, these prongs passing within the eighth sternite. At the base of these prongs, on the ventral surface of the sternite, is a triangular outgrowth directed forward. The place of the ninth tergite is taken by an extension of the upper apical

part of the sternite, this extension taking the usual hood-shaped form of the true tergite. The apex of the "hood" is broadly excised, and the sides, at the base, are not continuous with the segment. It is possible that this "hood" is really the ninth tergite, which has become fused with the sternite, but to all appearance it is a true outgrowth of the sternite, in which case the ninth tergite, as in *Micropteryx*, has disappeared. There are no true valvae in this species, their place being taken by a pair of small outgrowths from the sternite, situated a little above the usual position of the valvae. This is a very remarkable specialisation as the valvae are almost invariably present in the Lepidoptera, and it may be possible that the single specimen dissected had by some means lost the organs.

Suggestions and Conclusions.

In the higher Lepidoptera the structure known as the tegumen is generally considered as being made up of the ninth sternite and tergite. The parts, however, are so completely changed in shape that there may well exist a doubt as to their identity. In *Sabatinca*, though consider-

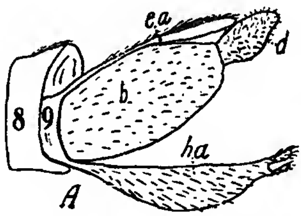


FIG. 19.—*Chorista australis* Klug, ♂.

able modification has taken place, the parts have retained more of the shape usually associated with abdominal sclerites. There is, however, a somewhat unexpected feature present in connection with the sternite. In some species of the genus the ninth sternite completely encircles the abdomen, forming a well-chitinised band of greater or lesser breadth. In other species the sternite is produced upwardly on each side so as to form forks or prongs which sometimes almost meet above the abdomen. In yet other forms the sternite is hardly modified at all in this direction. Now, those species which have the complete chitinous ring are

in other respects the most primitive forms of the genus. In *calliarcha* the dorsal band is broad, as it is also in *eodora*; in *lucilia* though the "arms" are broad and meet dorsally they are only membranously connected. These three species would be, I think, generally admitted to belong to the more generalised type of the genus, and there is no room for doubt that *zonodoxa* and the Australian *calliplaca* are among the most specialised of the forms. Yet, in these two latter the ninth segment is hardly produced upwards at all. In the forms with the complete ring, as in those with the arms or prongs, there is no indication of a pleural region, nor anything to prevent the piece from being considered as one sclerite. It is, then, permissible to suggest that in the ancestors of *Sabatinca* the ninth sternite took the form of a strongly chitinised band encircling the abdomen, the

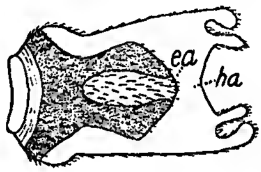


FIG. 20.—*Chorista australis* Klug, ♂, dorsal view of ninth segment, to show upper and lower prolongations.

ninth tergite being pushed out of its place and compelled to take up a position distad of it. If we turn to the more primitive Mecoptera, e.g. *Bittacus* (Fig. 17; see also *Harpobittacus*, Fig. 18A and B) we find the ninth segment not essentially different from that of the *calliarcha* section of *Sabatinca* (Figs. 2A and B, and 3A and B). The ninth sternite is similarly narrowly produced upwards and the tergite is articulated to this upper part, projecting over the anal region and the external genitalia and becoming, in effect, a dorsal appendage of the sternite. It is divided apically by a deep founded cleft into two lateral lobes, in this respect agreeing exactly with the species of *Sabatinca* referred to above. The ninth sternite, however, does not show the tendency towards enlargement so noticeable in *Sabatinca*; both the eighth and ninth sternite are, in fact, somewhat reduced dorsally, possibly as a result of the great development of the basal segments of the claspers (*pedes genitales*).

In the other genera of the *Bittacidae* there is little differ-

ence in the structure of the ninth segment. In the more specialised groups of the Mecoptera the segments from the sixth or seventh to the end of the abdomen are without any trace of a pleural region; apparently the pleurite has become entirely chitinised, though the spiracles are still present in their usual positions. In the Panorpidae the ninth segment is greatly prolonged both dorsally and ventrally (Figs. 19 and 20). These prolongations show no sign of articulation and the dorsal one could only give rise to the Micropterygidian homologue by a dechitinisation of the pleurite, a not very probable development. As far, then, as the ninth tergite is concerned, there is no reason why the Lepidoptera should not have been derived from a mecopterous form like *Bittacus*. It has been shown that there is practically no difference between the ninth tergite of *Bittacus* and that of a section of the lepidopterous genus

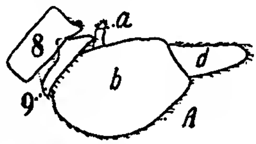


FIG. 21.—*Choristella philpotti* Till. ♂.

Sabatinca. It is not intended, however, on the strength of this fact, to suggest the derivation of the rest of the Lepidoptera from the Micropterygidae; the absence, or vestigial condition, of the eighth sternite in this family is alone sufficient to render such a derivation very improbable; but the same objection does not apply to the Eriocraniidae.

Turning now to the genital clasping organs of the Mecoptera, a more difficult problem presents itself. In this order the clasping organs (valvae or genital styles of the Lepidoptera) consist of two segments. The basal ones are usually fused into one large, more or less oval, organ which lies with its base hidden within the ninth segment (Fig. 21). The second segment (forceps or chelae) is comparatively small, curved inwards at the apex and armed with papillae or hairs within. The Bittacidae, or, at least, some members of the family, have a very small second segment. This is difficult to see in dried specimens and it has consequently often been overlooked. Whether this

feature is constant throughout the family I am unable to say, but I have found it so in all the species which I have been able to examine. I give a figure of *Harpobittacus australis* Klug (Fig. 18).

No Lepidopteron has a two-segmented valva, and the Bittacidae, with the vestigial second segment, therefore come nearest to the Lepidoptera in this respect, as in the structure of the ninth tergite. But, in the evolution of the unsegmented lepidopterous valva, are we to consider the method to have been the disappearance of the second segment and the dividing of the basal piece into two structures, or the disappearance of the basal segment and the modification of the second? Or did the Lepidoptera branch off from a mecopterous type which had not yet evolved the fused basal pieces? In any case a segment had to be got rid of, and it seems probable that the apical one would be the most likely to disappear. It is, however, well to remember that in the Lepidoptera there is usually a small plate to which the bases of the valvae are attached, and that this plate (referred to above as the horizontal plate) is frequently of considerable size in the Micropterygidae. It is just possible that this plate represents the basal segment of the mecopterous clasper.

I desire to acknowledge my great indebtedness to Dr. Tillyard, Chief of the Biological Department of the Cawthron Institute, for his encouragement and help during the progress of this study. It should be stated that Fig. 20 is taken from Esben-Petersen's "Monographic Revision of the Mecoptera" (de Selysian Collections), p. 157.

Abbreviations in Text-figures.

The segments are indicated by numbers, and the letters "t" and "s" placed to the right of the number indicate respectively the tergite and sternite.

a. Anus.
aap. Apical armature of penis.
ae. Aedeagus.
ap. Anal plates.
b. Basistylus (basal segment of clasper).
bp. Basal prongs of ninth sternite.
d. Dististylus (distal segment of clasper).
ea. Epiandrium (dorsal prolongation of ninth segment).

f. Filament of penis.
h. Harpes.
ha. Hypandrium (ventral prolongation of ninth segment).
hp. Horizontal plate.
mp. Processes for the attachment of muscles controlling valvae.
o. Orifice of penis.
os. Outgrowth of ninth sternite (?).
sa. Supra-anal hooks.
v. Valva.
A. Lateral view of terminal segments.
B. Dorsal, or ventral, view of ninth tergite.
C. Valva and horizontal plate.
D. Aedeagus.
E. Dorsal view of ninth sternite.

XIX. *On the African Species of the Dynastid Genus Heteronychus.* By Rupert W. Jack, F.E.S., Chief Entomologist, S. Rhodesia.

[Read October 17th, 1923.]

Plates XVI—XXI.

The following attempt to introduce order into a much neglected genus has been undertaken in the natural home of the insects involved, but unfortunately at a very great distance from the centres in which most of the type specimens of the described species have accumulated. Consequently considerable difficulties have had to be surmounted, and the result falls far short of the writer's aspirations. In point of fact, without inspecting practically all the type specimens in the various European museums, a proceeding which would only be possible to an entomologist with both leisure and means, a complete clearing up of the prevailing obscurities is an impossibility. It may further be emphasised that even this proceeding would in some cases probably fail in its object seeing that a number of species have been described on the basis of single female specimens only, and that in the case of this sex positive identification even in respect of well-established species is sometimes a matter of great difficulty.

The undertaking generally has only been rendered possible through the kind assistance of Dr. Guy Marshall, who not only furnished the writer with all the necessary original descriptions which could be traced, but afforded further practical help in arranging for the African species in the British Museum to be forwarded to Sali. bury. This, with the co-operation of the various museums in South Africa and the not inconsiderable collection at Salisbury, together with specimens specially procured from Europe, has rendered possible an examination of the great majority of the African species described to date.

It is freely admitted that in spite of the care exercised incorrect identifications may possibly have been made, as the earlier descriptions are mostly of a very meagre nature, but it is hoped that no instance of this nature will be found.

Where any doubt has existed it has been thought better to describe the species under a new name rather than to identify the specimens with any existing species. On this account it is far more probable that the serious offence of increasing the synonymy of the genus may have been perpetrated. If so the writer tenders his apologies to all subsequent students of the group, whilst pleading in extenuation the inadequacy of the earlier descriptions and the lack, in all but a few instances, of figures of the male genital armature which constitutes such a valuable key to specific identity. No new species have been erected in the present paper except where it has been possible to figure the male genital armature, and it is hoped that, whatever may be the ultimate fate of some of the names, the actual identity of the species herein described will not be very much in doubt.

The writer has great pleasure in expressing his indebtedness to Dr. Guy Marshall for his unfailing help and encouragement at all stages of the work, and to Mr. G. J. Arrow for the loan of the British Museum collection and useful advice. Grateful acknowledgments are also due to Dr. Péringuey of the South African Museum, who promptly and courteously responded to a request for the loan of certain of his type specimens; to M. Pierre Lesne of the Paris Museum, who presented the writer with certain co-types and forwarded others on loan; to M. E. Benderitter for opinions concerning the identity of certain species; to Dr. Walther Horn, who put himself to considerable trouble to compare certain specimens with types in the Berlin Museum; to Mr. C. Swierstra, Dr. E. Warren and Mr. E. C. Chubb for the loan of the collections in the Transvaal, Maritzburg, and Durban Museums respectively, and to the following who generously presented the writer with valuable material :—Mr. T. J. Anderson, Government Entomologist, Kenya Colony; Dr. H. Brauns, Willowmore, Cape Province; Mr. D. Gunn, Eastern Province Entomologist, Port Elizabeth; Mr. J. Hewitt, Albany Museum, Grahamstown; Mr. C. P. Lounsbury, Chief, Division of Entomology, Pretoria; Mr. C. W. Mally, Senior Entomologist, Cape Town, and the Rev. J. O'Neil, S.J., Salisbury, Southern Rhodesia.

With the exception of the male of *H. Vix-striatus*, types of all the species here described as new are in the British Museum.

Economic and Bionomic.

Several species of *Heteronychus* are of prime importance to the agriculturist. In Africa two are well-known pests, namely *arator* F., in the Cape Colony, chiefly in connection with attacks on maize, and *licas* Klug, as a pest of sugar-cane in the coastal districts of the tropics and in Natal. The latter species is also a very bad pest of maize in certain parts of Rhodesia, and in this connection has been recorded by the present writer under its synonym of *mashunus* Pér.* Other species, namely *inops* Pér., and *dissidens* Pér., have also proved capable of severe damage to maize crops on the Southern Rhodesian high veld, whilst the two new species *puncticollis* and *foveolatus* have been taken as isolated individuals also associated with this crop.

The range of food of the adults is not fully known, but *licas* at least appears to need growing plants and feeds chiefly on those of the grass family. The greater part of its life is spent underground, and injury to maize is caused by the beetle eating into the underground stem and thus killing the plant. The beetles seem peculiarly dependent upon moisture and die very quickly if enclosed under dry conditions, although they will live for months in a damp environment. In the field they are sometimes seen on the surface in numbers after rain, but not in dry weather; on damp evenings they are frequently attracted to light.

The larvae are typical Scarabaeid grubs and live in the soil. They resemble more closely the Rutelids and Melolonthids than the Coprids, and like members of the first two subfamilies attack the underground portions of plants, including maize and grass. Their main food, however, appears to be humus, and they thrive well in the absence of growing plants, provided there is sufficient decayed vegetable matter present in the soil. They have been reared successfully in confinement on a mixture of soil and rotten cattle-dung. The necessity of humus and moisture is also indicated by the classes of soil in which the insect breeds in nature with sufficient success to develop into a pest. *H. licas* in Southern Rhodesia passes through all its transformations in one year, and this is probably the general habit, at least in the tropics. The egg-laying and

* The Rhodesia Agricultural Journal, Feb. 1918: "The Maize Beetle."

growth of the larva are practically confined to the wet season. During the cold dry months (May to August) the larvae mostly lie up in a dormant condition in cells in the soil. Pupation takes place in September and October, and the adults, which break the pupal skin a few weeks later, remain in the cells until the advent of the rains, when they are stimulated into activity. They are most numerous during the latter part of November and in December and January. Very few linger on until May, but greatly worn specimens have been found in the field during the latter month.

Systematic.

The genus when first erected by Burmeister was far less restricted than it is at present. It included species from both the Old World and the New, but Dejean (Cat. ed. 3, p. 169) excluded all the New World species and was followed by Lacordaire (Gen. Coleopt., iii, 1856, p. 407). Prof. Kolbe (Entomol. Nachrichten, 1900, No. 11, p. 164) erected the genus *Heteroligus* to accommodate species, like *claudius* Klug, which have a distinct projection near the front margin of the prothorax, and wide, more or less intermingled, stridulating bands composed of very fine folds. Although *claudius* is the only species of this new genus familiar to the writer it may be mentioned that in addition to the characteristics mentioned, the anterior tarsi in the male of this species are slender, with the claws practically equal, a fact which in itself should be sufficient to place the species in a different genus. In the second part of his paper (Entomol. Nachrichten, 1900, No. 21, 324 *et seq.*) Prof. Kolbe, mainly on the basis of the authors' descriptions, excluded the following species from the genus: *paradoxus* Bhn.; *morio* Fabr.; *meles* Billberg; *impressicollis* Fairm.; *foveipennis* Fairm., and *digitatus* Brancsik. (a Madagascan species). The genus *Heteroconus* Kolbe was erected to accommodate the last-named species. The characters given by Kolbe to distinguish the genus from *Heteronychus* are:—The narrow projecting double-pointed epistome, the well-developed, complete transverse carina of the frons, the prosternal projections produced backwards into long sharp points, the wider-paired stridulating bands, confluent as in *Heteroligus*, and the more profuse punctate striae on the elytra.

The genus *Heteronychus* as now restricted, therefore, includes only species in which the dorsum of the prothorax is without definite projections * and two clear rows of stridulating folds are present on the propygidium. The conspicuous characteristic of the markedly unequal anterior claws of the males, which gave its name to the genus, does not seem to have been given full weight, for though both Lacordaire (*loc. cit.*) and Péringuey (Trans. S.A. Phil. Soc., xii, 1900, p. 513) mention it as a characteristic of the genus, both fail to exclude *claudius* Klug, in the male of which these claws are practically equal. Furthermore, Prof. Kolbe has described a species under the name of *camerunus*, apparently from a single specimen, which, although showing most of the characteristics of *Heteronychus*, is somewhat divergent in general facies, and the anterior tarsi of the males differ in no particular from those of the females. In the British Museum collection there are three examples of this species, which possesses clear characteristics and is easily recognised from the description. These include a male and female from Sierra Leone and a male from Angola. The males are not distinguishable from the females except by the emarginate terminal segment of the venter. It appears desirable that this species should be removed from *Heteronychus*, and Mr. Arrow is of opinion that it comes nearest to his genus *Alissonotum*.

Beyond the simple anterior tarsi of the males there is little to distinguish this species from *Heteronychus*, although *camerunus* Klb. presents certain characteristics which are at least unusual in that genus. The mentum is contracted near the apex, but is considerably broader behind the constriction than in any species of *Heteronychus* examined by the writer. The outer lobe of the maxilla appears to be 6-dentate and the mandibles are normal; the front margin of the clypeus is slightly different, being strongly reflexed and bidentate, but with a slight forward projection in the middle; the pygidium is far less convex than in any African species of *Heteronychus*, except *flavopilosus* Prell, and the latter is a doubtful member of the genus, the male being unknown. It is similar in both sexes, whereas in *Heteronychus* it is almost invariably more convex in the female. The punctate segments of the venter, especially the closely punctate terminal segment, are also apparently

* *H. niger* Klug shows a very faint trace of a median upward projection on the anterior margin.

not paralleled, nor the sparsely punctate sides of the metasternum, which are rugulose in *Heteronychus*, again with the exception of *flavopilosus* Prell, in which they are glabrous but sparsely and somewhat vaguely punctate.

Alissonotum (?) camerunus Klb.

(Plate XVIII.)

Heteronychus camerunus Klb., Arkiv. Zool., ii, 18, 1905, p. 5.

Black, castaneous beneath, form slightly elongate; front margin of clypeus with a blunt median projection and an extremely obtuse rounded angle on either side, strongly reflexed and bluntly bidentate; clypeus very weakly rugulose and glabrous; frons glabrous, in part punctate, slightly rugulose anteriorly; head with a strong median depression deeper on the frons than on the clypeus, bituberculate; clypeal carina not clearly differentiated, but a ridge runs from the margin on either side to the prominent tubercles; frontal carina visible as a slender thread on either side behind the tubercles, but obliterated medially; prothorax transverse, front margin somewhat arcuate, curved forward medially; lateral margins gradually attenuate from the base to the somewhat obtuse anterior angles; marginal stria extending round the basal angles and for a short distance on either side along the basal margin; surface smooth and shining but clearly punctate, more strongly laterally and anteriorly; scutellum ogival, glabrous, impunctate, with or without a median longitudinal impression; elytra about the same width as the prothorax at the base and not quite twice as long, slightly ampliated in posterior three-quarters; striae as in *Heteronychus*, more or less strongly paired, moderately impressed and coarsely punctate; broader intervals mostly with series of strong punctures; apices of elytra closely punctato-rugose, the punctures markedly smaller than those in the striae and dorsal intervals; stridulating rows on propygidium narrow, with folds coarser basally and fine apically, somewhat obsolescent towards apical margin; the rows are about three times their width apart at the base, subparallel for about half their length and slightly convergent thence towards the apical margin; pygidium little convex with surface entirely and closely punctato-rugose; pygidial fold narrow and simple; anterior tibiae acutely tridentate with the margin slightly angular above the basal projection; * prosternal

* These three specimens show hardly a trace of an intermediate denticle, and this the only respect in which they differ from Kolbe's description.

process subovate, strongly concave beneath; metasternum with a strong median impressed longitudinal line, glabrous, impunctate medially, sparsely but clearly punctate at sides; venter glabrous, in general sparsely but the terminal tergite closely, punctate; intermediate segments with a row of setigerous punctures; posterior margin of terminal segment entire in female, emarginate in male.

20–21 mm. × 10 mm. (19 mm. *fide* Kolbe).

Cameruns (*f.* Kolbe), Sierra Leone, Angola.

Genus Heteronychus Burm.

Handb. d. Entomol., V, p. 90 (2).

Mentum elongate, constricted laterally near the apex; in basal part longitudinally subcarinate in the middle, obliquely flattened and usually somewhat excavated anteriorly; labial palpi inserted laterally near the tip, 3-jointed, terminal joint nearly equal in length to first and second combined, nearly three times as long as broad, tapering to a blunt point; external lobe of maxilla armed with six sharp teeth arranged in two rows, the apical pair fused together basally with only the points free; maxillary palpi 4-jointed, apical joint elongate and slightly swollen; mandibles terminating in two strong somewhat recurved teeth projecting beyond the clypeus, outer margin sharply excurved and frequently clearly dentate behind the second tooth; head wide and short, clypeus much narrowed anteriorly, either plainly truncate with anterior margin sharply reflexed and more or less bidentate, or triangulate; clypeus separated from frons by a carina usually more or less widely interrupted medially and in some species forming a pair of prominent tubercles on either side of the interruption; behind this is a second carina (frontal), running close to the inner margins of the eyes, then turning inwards and approximating or coalescing with the clypeal carina on either side only to separate again in the median area, where it is either persistent or obsolete; prothorax transverse, moderately convex, glabrous, punctate or not, but without distinct projections, approximately the same width as the elytra basally and narrowed anteriorly, with the lateral margins smoothly rounded, emarginate anteriorly with the angles more or less projecting, usually slightly sinuate along the basal margin, the posterior angles being obtuse and more or less rounded; lateral margins lightly reflexed and together with the anterior margin marked with a closely approximated parallel stria, which may or may not extend for some distance on either side along the basal margin, very rarely along its entire length; scutellum moderately large and ogival; elytra convex,

declivous posteriorly and not quite covering the propygidium; surface ornamented with a series of punctate striae of which the first is close to and parallel with the suture, whilst the second to the seventh are parallel to each other but oblique, diverging anteriorly from the first; the eighth and ninth are more or less parallel with the lateral margin and slightly divergent posteriorly from the seventh; the second stria joins the sixth posteriorly and the fourth and fifth are sometimes abbreviated; the lateral striae from the sixth to the ninth do not reach the base of the elytra; intervals between the striae punctate or smooth, punctures usually confined to the even-numbered intervals; apices of elytra more or less closely pitted; propygidium furnished medially with two longitudinal bands of stridulating folds, subparallel or divergent from each other posteriorly; pygidium convex, with a prominent fold along the anal margin, in some females bluntly pointed and transversely subcarinate; prosternum with a posterior setigerous subovate process projecting behind the coxae; metasternum glabrous medially with a median longitudinal impression but rugulose at the sides; intermediate abdominal segments usually with a transverse row of setigerous punctures close to their posterior margins; apical segment of the venter emarginate posteriorly in the middle in the males, entire or only very slightly sinuate in the females; anterior tibiae with three strong teeth and a varying number of small projections or denticles, one of which is commonly intermediate between the basal and middle major teeth; front tarsus of male shorter than that of female and much swollen, the inner claw laminate, much dilated and abruptly curved downward, the outer claw being more or less normal; front tarsus of female slender with the claws simple and equal.

Specific Characteristics.

(Plate XVI.)

The African species of the genus for the most part very much resemble each other in general characteristics, and identification is a matter of considerable difficulty. The species are, in fact, distinguished by somewhat obscure external characters which are naturally subject to considerable individual variation and certainty in identification is hardly possible without good figures of the male genital armature: This fact was apparently first recognised by Dr. Lionel Péringuey of the S.A. Museum, who has figured these organs in respect to some thirteen

species, some of which, however, appear to be synonymous. Apart from these the only other figures published appear to be those in connection with M. Benderitter's three species (" Voyage de Ch. Alluaud et R. Jeannel en Afrique Orientale " (1911–12), Resultats scientifiques, Coleoptera xii, pp. 385–398). This leaves nearly three-quarters of the published descriptions to be recognised by external characters alone, and even these are very inadequately dealt with by several authors. The naming of new species on the basis of one or two female specimens, without very pronounced characteristics, is a practice which can only be deplored. The position is much the same with single males, if the genital armature is not figured, except that the omission can be rectified if one has access to the type.

The form of the male genital armature, although constituting the most valuable key to specific identity, does not remove the last difficulty. The form is not always very clearly distinct in distinct species. This is exemplified in the case of *niger* Klug and *tenuestriatus* Fairm., in which the male genitalia are very similar although the species are clearly distinct. On the other hand, too much weight must not be given to slight differences in the genitalia in specimens otherwise similar, as these organs are, of course, subject to some variation.

(1) *Colour and Facies.*—The great majority of species are shining black dorsally with varying proportions of the underparts and appendages castaneous or ferrugineous. Wholly castaneous specimens are frequent in many species, however, particularly in those of the second group, represented by *arator* F. *H. inops* Pér., for instance, is quite as often castaneous as black, whilst *fossor* Reiche varies from fuscous to castaneous, no black specimens being included amongst the four examples examined by the writer. The two superficially similar species *parumpunctatus* Burm. and *puncticollis* m. are indifferently dark chestnut or black, and in these species the surface is slightly dull. Dullness of the surface is also induced by wear, however, and speaking generally neither colour nor surface are of much value in specific differentiation.

The shape throughout the whole of the African representatives of the genus is remarkably uniform. Slight differences exist in the proportion between the length and breadth, but they are hardly noticeable except to the practised eye. As a general rule the extreme width is

about half the length, but is usually slightly greater, rarely very slightly less.

(2) *Head*.—The form of the front margin of the clypeus, as emphasised elsewhere, is of great value in regard to grouping. The *sculpture* also varies somewhat, but not sufficiently to be of prime importance. The presence or absence of a median *impression*, which when present generally embraces a portion of both clypeus and frons is apparently a reliable characteristic. The transverse ridge separating clypeus and frons is mentioned by most authors, but Dr. Péringuey alone has distinguished between the clypeal and frontal carinae. This distinction is of the greatest value and should be perpetuated. The clypeal carina is practically obliterated in several species, whilst the frontal carina is distinct; the clypeal is often interrupted and the frontal entire, or both may be interrupted; the clypeal may be raised and conspicuous, the frontal fine and inconspicuous or altogether wanting (e. g. *flavopilosus* Prell); the clypeal is generally more or less straight, the frontal curved and frequently retrosely angulate medially, and other variations occur.

The vertex of the head is practically always smooth and glabrous but the extension of the sculpture behind the carinae may vary somewhat in different species.

(3) *Prothorax*.—Although commonly described in detail the shape of this segment varies comparatively little and is of small value, in the general way, in regard to identification. It is, however, noticeably longer than usual in one or two species (e. g. *infans* Klb., and *impudens* m.). The surface is in the majority of species apparently smooth and impunctate, but in reality very finely and obscurely punctate especially towards the sides and front angles. In some species the prothorax is distinctly punctate and this constitutes a good characteristic. The extent to which the marginal stria extends if at all along the basal margin is somewhat variable. In one species (*foveolatus* m.) it extends along the whole margin although occasionally somewhat obscure medially.

(4) *Scutellum*.—It is quite the exception for the scutellum, as in the new species *foveolatus* m., to be other than definitely impunctate. There is commonly a faint median longitudinal impression, obliterated, however, in many individuals. A short blunt impression, as in many specimens of *transvalicus* Klb., is unusual.

(5) *Elytra.*—The proportionate length of these is variable within narrow limits only. They are usually slightly longer than wide, but the two dimensions may be approximately equal as in *parumpunctatus* Burm., *puncticollis* m., etc., whilst in *amplipennis* Bend. they are wider than long.

They are usually more or less ampliated posteriorly from a sinuation of the margin one-fourth to one-third of the length from the base, but in some species the margins are nearly parallel as far as the posterior attenuation.

The striae exhibit certain characteristics in relation to their depth, punctation and arrangement in pairs or otherwise, but there is considerable individual variation in these respects, not however, sufficient entirely to destroy their value as characteristics in certain species. The pairing or otherwise of the striae is apparently very unreliable, and seems to have some slight connection with locality, but in some species the pairing is very strong and seems to be definite. The striae are invariably paired: 2–3, 4–5, 5–6, 7–8. This arrangement leaves the second, fourth, sixth, and eighth intervals wider than the others, and in general the narrower intervals are impunctate, whilst the broader ones may be punctate or not, and this holds whether the striae are paired or otherwise. A few seemingly accidental punctures may occur on some of the odd-numbered intervals, but as a broad statement it is the even-numbered intervals which are liable to both broadening and punctation. The eighth interval is rarely altogether free from punctures, but the dorsal intervals 2, 4, and 6 may be definitely impunctate or definitely punctate, but in some species, such as *arator* F., they may be either. Even in species like *licas* Klug, which have the dorsal intervals definitely punctate, occasional individuals occur in which these intervals are entirely smooth, and the reverse may occur in species with normally impunctate intervals.

The lateral striae, namely from the sixth outwards do not reach the base of the elytra, the sixth itself being frequently much abbreviated in this respect. The seventh and eighth are as a rule either more deeply impressed or more coarsely punctate for a short distance near their basal ends, but weaken considerably apically, and the eighth may be practically obsolete in the apical three-quarters. The ninth is always a weak stria throughout and may be entirely obsolete. The third, fourth and fifth

striae are subject to abbreviation behind, but there seems to be much individual variation in this respect.

The apices of the elytra are in general closely foveolate-punctate and vary but little.

(6) *Stridulating Bands.*—The term "bands" is used in preference to "striae," which is far more common, for the reason that the latter term rather suggests the striae between the individual folds in the rows and renders detailed description somewhat confused. These organs are of great value in classification, and the writer has been at some pains to describe them in detail in respect to each species. It is, however, easy to overrate their value as they vary considerably in individuals. Few authors mention these organs, possibly because they are difficult to examine without relaxing the specimens. Prof. Kolbe usually gives a brief description and Dr. Péringuey utilises them to some extent, particularly in regard to species related to *niger* Klug, which have these organs of a very characteristic type. The various descriptions given are, however, to the writer's mind, usually inadequate. The rows present other characteristics than these indicated in the words "broad," "narrow," "parallel," "divergent," etc. The folds are as a general rule noticeably coarser and more widely spaced basally, frequently very strikingly so, but this characteristic is not always very noticeable, e. g. *niger* Klug, *wilmsi* Klb., *cricetus* Hausm. and particularly *impudens* m. The rows again are usually broader towards the basal margin of the segment and frequently several times as broad as in the apical portion, but they may be even in width throughout or even slightly broader apically as in some males of *arator* F. Again the rows may be straight or curved, subparallel throughout, subparallel in the basal half and divergent in the apical or vice versa.

(7) *Pygidium.*—This segment affords some useful characteristics. Variations in shape are dealt with under "Sexual Divergence." The surface varies from entirely rugose or punctate to almost entirely smooth. In the majority of species there is a rugulose or punctate basal band of varying width, the apex being smooth. Reduction of the rough area is invariably apparent from the apex to the base of the segment. The fold along the anal margin presents definite characteristics in a few species, *e. g.* those closely related to *niger* Klug.

(8) *Anterior Tibiae.*—These are, broadly speaking, always

tridentate, but a small denticle frequently intervenes between the two basal major teeth, and from one to four may occur above the basal tooth. The presence or otherwise of these denticles appears to be reasonably constant, except that the number of basal ones is apt to vary in species which possess more than one. Wear affects the anterior tibiae quicker than almost any other part of these beetles, and the small denticles may be obliterated. The first to go are the basal ones in the species which have the outer margin of the tibia above the basal tooth composed of a somewhat thin lamina of chitin. The basal denticle in such species is usually rather an angulation of the margin than a distinct projection. The presence or absence or the number of basal denticles is in some species a sexual characteristic.

(9) *Pectus and Venter.*—The underside of the body appears to present little in the way of specific distinctions. The prosternal process is mentioned by several authors, but really varies too little to be of value, and the same may be said of the metasternum in respect to the median impressed line or other features. Dr. Péringuey frequently mentions the rows of setigerous punctures close to the hind margins of the intermediate segments of the venter, but although the number varies considerably it is not specifically constant.

Sexual Divergence.

(Plate XVII.)

The most obvious distinction between the sexes lies in the thickened anterior tarsi and dilated inner tarsal claw of the male. The terminal plate of the venter is also emarginate posteriorly in the male and entire in the female (see Plate XVII). These constitute reliable means of distinguishing the sexes, but certain other parts are also liable to vary in shape. The interruption of the clypeal carina tends to be rather wider in the female than in the male (e. g. *licas* Klug) whilst in certain species which have a punctate or rugulose band along the base of the pygidium the band is commonly rougher and wider in the male, usually weakening very much in the centre in the female. The pygidium itself tends to be more convex both longitudinally and transversely in the females, and in the latter sex is frequently subcarinate transversely and impressed

beneath (e. g. *consimilis* Klb., *transvalicus* Pér., *dissidens* Pér., *obtusifrons* Fairm., etc.), whilst the pygidial fold is in certain species broader in the middle in the male (e. g. *licas* Klug, *tenuestriatus* Fairm., *niger* Klug), and where a median excavation is present it may be of a different form in the two sexes (e. g. *tenuestriatus* Fairm.). The stridulating bands on the propygidium are usually narrower in the female. Occasionally the anterior tibiae may show a basal denticle in the female, which is absent or only faintly indicated in the male (e. g. *puncticollis* m.), or the female may possess more than the male (e. g. *cricetus* Hausm.).

Subdivision of the Genus.

The shape of the male genital armature and the stridulating bands on the propygidium appear to be of comparatively little value in denoting relationship, for although both or one of these organs are often more or less similar in species which in other respects show decided affinity, striking exceptions are very frequent. For example, in the three allied species *niger* Klug, *tenuestriatus* Fairm. and *cricetus* Hausm. both the male genitalia and the stridulating bands are very similar; in *licas* Klug, *consimilis* Klb., *transvalicus* Klb. and *obtusifrons* Fairm., the stridulating bands are much alike and the male genitalia show a strong general resemblance, except in *consimilis*, in which they are markedly dissimilar; in *dissidens* Pér. the male genitalia show a likeness to those of *licas*, *transvalicus*, and *obtusifrons*, but the stridulating rows are very different; *andersoni* m. is clearly related to some other species which exhibit an outward projecting barb near the distal end of the male genital armature, but the stridulating bands are unlike those of related species. Dr. Péringuey has suggested a grouping of the South African species of the genus on the basis of the form of the stridulating bands (Trans. S.A. Phil. Soc., xii, 1901, p. 513), but this grouping merely separates the three first species mentioned above from the rest, and to attach the same value to the form of these organs throughout the genus would be altogether arbitrary.

A subdivision which appears to be in accordance with natural affinities is that suggested by Prof. Kolbe (Entomol. Nachrichten, No. 11, p. 164). The basis is the form of the front margin of the clypeus, which is either plainly truncate

or triangulate. This basis divides the African species into two nearly equal groups. It must be pointed out, however, that in the second group there are two distinct forms of clypeus. In the one, of which *arator* F. is a representative, the margin on either side between the median projection and the obtuse lateral angles is incurved and strongly reflexed, the reflexed portion being rounded or subdentate; in the other, e. g. *fossor* Reiche, the margin of the clypeus is very weakly reflexed and is not incurved on either side of the median angle, so that the latter is very obtuse, in fact the whole front margin may be almost rounded. The species with the latter form of clypeus appear to form a very natural little subgroup, comprising *fossor* Reiche, *ascanius* Klb. (prob. a synonym of *fossor*), *memnonius* Klb., *puncticollis* m., with *insignificus* m. apparently is not quite so closely allied. Very similar in most characteristics to *puncticollis* m. is *parumpunctatus* Burm., and the two are evidently somewhat closely related, but the front clypeal margin in the latter species is of the *arator* type, and this fact appears to militate against a further subdivision of the group on the basis of the characteristics under consideration.

On the whole, therefore, it appears safest to confine the subdivision of the genus to the two groups as indicated. The form of the clypeus, it may be mentioned, although quite clear in fresh specimens is apt to be somewhat obscured by wear, the subterranean habits of the beetles exposing the chitin to continuous erosion. Unless very much worn, however, the original form can be detected without much difficulty.

The two groups are, therefore, as follows :—

Group I. Clypeus plainly truncate in front, where the margin is reflexed and bidentate or bisinuate, e. g. *licas* Klug.

Group II. Clypeus triangulate, in some species almost rounded anteriorly, e. g. *arator* F.

The difference in the form of the clypeus may be seen by referring to the figures illustrating the two species cited as examples of the groups.

The following is a provisional attempt to place the species in the order of their natural affinities. This arrangement is doubtless open to much criticism, the data being in point

of fact insufficient in respect to several species, and in any case opinions are likely to differ concerning the significance of various characteristics.

The aberrant *flavopilosus* Prell, if it belongs to the genus at all, falls into Group I, but as it shows affinities with other genera it is placed by itself at the beginning. The next four species, *niger* Klug, *tenuestriatus* Fairm., *cricetus* Hausm. and *amplipennis* Bend., form a very homogeneous subgroup in possessing a broad fold to the pygidium with a conspicuous median excavation, broad stridulating bands composed of fine folds and a tendency to multiplication of the basal denticles on the anterior tibiae. Next would appear to follow the species such as *licas* Klug and *gerstaeckeri* Klb. and any other species of the group in which the pygidium is smoothly convex in both sexes. In *vix-striatus* m. the pygidium is slightly impressed beneath in the female. Following these we have a number of closely related species in which the female pygidium is somewhat pointed and transversely subcarinate. These include *atratus* Klug, *obtusifrons* Fairm., *dissidens* Pér., *consimilis* Klb. and *nitidus* Bend. Unfortunately in respect to several species the male only is known and in others the description is too vague to admit of the affinities of the species being much more than guessed at. The latter remark applies to *laevilineatus* Fairm. and *densatifrons* Fairm. The new species *angolensis* m. is, however, obviously closely related to *dissidens* Pér. and *costutus* Lansberge (if it is not actually the latter species), and it may be associated with these species with tolerable confidence. The two smallest species of the group, namely *infans* Klb. and *impudens* m. are only known by the males and their affinities are obscure.

In the second group the species which show an intermediate denticle on the anterior tibiae may be placed first, namely *arator* F., *rugifrons* Fairm., *pygidialis* Klb., *muticus* Bend., *tristis* Bhn. and *andersoni* m. In *arator* and *rugifrons* the pygidium is almost entirely smooth, in *pygidialis* the basal band is more broadly but very finely rugulose; in the last three the band is coarse and broad, which leads to *congoensis* Klb., *puerilis* Klb.(?) and *foveolatus* m. as the first three species in the subgroup lacking an intermediate denticle. These would seem to be followed by *approximans* Klb. and *inops* Pér., in which the basal band in the pygidium is narrower and weaker, and *beiranus* Pér., *mosambicus*

Pér., *simulans* m., in which the pygidium is again practically smooth. There seems little doubt that *parumpunctatus* Burm. is intermediate between the members of the group which have the clypeal margin with an acute median angle and those which have this angle obtuse and the margin very slightly reflexed. The latter comprises four species, namely, *puncticollis* m., *memnonius* Klb., *fossor* Reiche and *insignificus* m. The species *rudestriatus* Fairm., *ascanius* Klb., and *modestus* Thomson are assumed to be synonyms of *fossor*, otherwise they would, of course, be associated with this species.

The arrangement tentatively suggested is, therefore, as follows, the species thought to be particularly closely allied being enclosed in brackets :—

GROUP I. (*flavopilosus* Prell); (*niger* Klug; *tenuestriatus* Fairm.; *amplipennis* Bend.; *cricetus* Hausm.); *licas* Klug; *gerstaeckeri* Klb.; *vix-striatus* m.; *laevilineatus* Fairm. (?); *abyssinicus* m. (?); (*consimilis* Klb.; *transvalicus* Klb.; *indotatus* Pér.; *obtusifrons* Fairm.; *atratus* Klug; *dissidens* Pér.; *costatus* Lansberge; *angolensis* m.); *infans* Klb.; *impudens* m.

Pos. om. incert :—*densatifrons* Fairm.

GROUP II. *arator* F.; *rugifrons* Fairm.; *pygidialis* Klb.; *muticus* Bend.; *tristis* Bhn.; *andersoni* m.; *congoensis* Klb.; *puerilis* Klb. (?); *foveolatus* m.; (*approximans* Klb.; *inops* Pér.; *beiranus* Pér.; *mosambicus* Pér.; *simulans* m.); *parumpunctatus* Burm.; (*puncticollis* m.; *memnonius* Klb.; *fossor* Reiche.); *insignificus* m.

DISTRIBUTION OF SPECIES.

The following is an attempt to illustrate in a graphic manner the distribution as far as known at present of the species described to date. The writer has met with no record of the occurrence of any member of the genus north of the latitude of Senegal in the west and southern Nubia (Blue Nile) in the east, nor in the arid regions of south and south-west Africa, but it is probable that the genus is represented throughout the whole of the intermediate area.

The compass points in the headings of the table include the following states :— N.W. = Upper Guinea, *i. e.* from Senegal to Nigeria (inclusive); W. = Lower Guinea, *i. e.* from the Cameroons to Angola (inclusive); N.E. = Abyssinia, Soudan and Somaliland; E. = Kenya, Uganda,

Tanganyika and Moçambique (N. of Zambesi); C. = Congo State and British Central Africa; S. = area south of Zambesi River.

Species.	N.W.	W.	N.E.	E.	C.	S.
flavopilosus Prell.						+ ?
niger Klug.	+		+	+	+	+
tenuestriatus Fairm.		+	+	+	+	+
amplipennis Bend.				+		
cricetus Hausm.						+
licas Klug.	+	+	+	+	+	+
gerstaeckeri Klb.				+		
vix-striatus m.						+
laevilineatus Fairm.						+
abyssinicus m.			+			
consimilis Klb.			+	+		+
transvalicus Klb.						+
indotatus Pér.						+
obtusifrons Fairm.				+		
atratus Klug.				+ ?		+
dissidens Pér.					+	+
costatus Lansberge.		+				
angolensis m.		+				
infans Klb.						+
impudens m.			+			
densatifrons Fairm.			+			
arator F.			+	+	+	+
pygidialis Klb.				+	+	
muticus Bend.				+		
tristis Bhn.						+
andersoni m.				+		
congocnsis Klb.					+	
puerilis Klb.		+				
foveolatus m.		+				+
approximans Klb.						+
inops Pér.		+				+
beiranus Pér.						+
mosambicus Pér.						+
simulans m.					+	
parumpunctatus Burm.			+			+
puncticollis m.						+
memnonius Klb.		+				
fossor Reiche.	+		+			
ascanius Klb. (? = *fossor* Reiche).	+					
rudestriatus Fairm. (? = *fossor* Reiche).			+			
modestus Thomson (? = *fossor* Reiche).		+				
insignificus m.			+			

It appears from the above that *licas* Klug is the most widely distributed species, closely followed by *niger* Klug and *tenuestriatus* Fairm., but it is not impossible that these two species may yet be found in the W. and N.W. divisions respectively. The range of *tenuestriatus* Fairm. extends further south than that of *licas* Klb. as it is reported from the south coast of the Cape Colony (*fide* Péringuey), whereas the writer has no record of *licas* south of Natal, although one would expect its occurrence in Pondoland at least. The predominance of the southern area in species is probably due to superior records.

The following is a list of all the African states in which members of the genus have to the writer's knowledge been recorded, with the various species against each :—

Senegal. (1) *niger* Klug; (2) *licas* Klug ; (3) *fossor* Reiche; (4) *ascanius* Klb., prob. syn. of *fossor*.

French Congo. (1) *modestus* Thomson, prob. syn. of *fossor ;* (2) *licas* Klug ? (" Afr. Occid. Congo "); (3) *foveolatus* m.

Angola. (1) *wilmsi* Klb.; (2) *angolensis* m.; (3) *costatus* Lansberge; (4) *puerilis* Klb.; (5) *memnonius* Klb.; (6) *inops* Pér.

Belgian Congo. (1) *licas* Klug ? (v. supra); (2) *congoensis* Klb.; (3) *simulans* m.; (4) *arator* F.

Soudan. (1) *niger* Klug; (2) *licas* Klug; (3) *parumpunctatus* Burm.; (4) *fossor* Reiche.

Abyssinia. (1) *tenuestriatus* Fairm.; (2) *consimilis* Klb.; (3) *impudens* m.; (4) *arator* F.; (5) *fossor* Reiche; (6) *rudestriatus* Fairm. = ? syn. of *fossor* Reiche; (7) *densatifrons* Fairm.; (8) *insignificus* m.; (9) *abyssinicus* m.

Kenya Colony. (1) *tenuestriatus* Fairm.; (2) *consimilis* Klb. = *nitidus* Bend.; (3) *amplipennis* Bend.; (4) *obtusifrons* Fairm.; (5) *arator* F.; (6) *muticus* Bend.; (7) *andersoni* m.

Uganda. (1) *tenuestriatus* Fairm.

Tanganyika Territory. (1) *niger* Klug; (2) *licas* Klug; (3) *consimilis* Klb.; (4) *atratus* Klug ?; (5) *gerstaeckeri* Klb.; (6) *arator* F.; (7) *pygidialis* Klb.; (8) *obtusifrons* Fairm.

Nyasaland. (1) *tenuestriatus* Fairm.; (2) *licas* Klug; (3) *dissidens* Pér.

N. Rhodesia. (1) *niger* Klug; (2) *tenuestriatus* Fairm.; (3) *licas* Klug; (4) *arator* F.; (5) *pygidialis* Klb.

Moçambique. (1) *niger* Klug; (2) *licas* Klug; (3) *atratus* Klug; (4) *laevilineatus* Fairm.; (5) *infans* Klb.; (6) *mosambicus* Pér.; (7) *beiranus* Pér.

S. Rhodesia. (1) *niger* Klug; (2) *tenuestriatus* Fairm.; (3) *licas* Klug; (4) *consimilis* Klb.; (5) *dissidens* Pér.; (6) *arator* F.; (7) *inops* Pér.; (8) *foveolatus* m.; (9) *parumpunctatus* Burm.; (10) *puncticollis* m.

Transvaal. (1) *niger* Klug; (2) *tenuestriatus* Fairm.; (3) *licas* Klug; (4) *transvalicus* Klb.; (5) *indotatus* Pér.; (6) *vix-striatus* m.; (7) *arator* F.; (8) *approximans* Klb.; (9) *inops* Pér.?

Orange Free State. (1) *tenuestriatus* Fairm.

Natal. (1) *niger* Klug; (2) *tenuestriatus* Fairm.; (3) *licas* Klug; (4) *vix-striatus* m.; (5) *transvalicus* Klb.; (6) *tenuestriatus* Fairm.; (7) *arator* F.; (8) *tristis* Bhn.

Cape Colony. (1) *tenuestriatus* Fairm.; (2) *cricetus* Hausm.; (3) *transvalicus* Klb.; (4) *vix-striatus* m.; (5) *flavopilosus* Prell? (6) *arator* F.; (7) *tristis* Bhn.

There are many apparent gaps in the above record. It seems highly probable that *licas* Klug occurs in Abyssinia, Uganda and Kenya. The occurrence of *tenuestriatus* Fairm. in the Upper Guinea Area also appears at least possible, seeing how widely distributed it is elsewhere, and this species is almost certain to occur in Tanganyika Territory. Similarly, *arator* F. no doubt occurs in both Moçambique and Nyasaland.

KEY TO THE AFRICAN SPECIES OF *HETERONYCHUS*

The writer's experience in the use of dichotomic keys to specific identity has not induced an exaggerated idea of their practical value, but a revision of a genus without such a key would be a departure from well-established precedent. The following is, therefore, presented without any illusions as to its shortcomings.

Note.—The species marked * by the writer have not been examined.

Group I. Clypeus plainly truncate anteriorly where the margin is reflexed and more or less bidentate.

I. Pygidium very slightly convex dorsally; sides of metasternum sparsely punctate . . . *flavopilosus* Prell.

Pygidium strongly convex dorsally; sides of metasternum closely rugulose . . . . II.

II. Pygidial fold broad in both sexes with a median excavation. III.

Pygidial fold narrow without a medium excavation. VI.

III. A faint knob on anterior margin of prothorax with a shallow impression behind; excavation in pygidial fold triangular in both sexes, the apex of the triangle *towards* the anal margin . . . . *niger* Klug.

No knob on anterior margin of prothorax; excavation in pygidial fold not triangular in males; when of this form in the females the apex of the triangle directed *away from* anal margin . . . . IV.

IV. Excavation in pygidial fold transverse and fusiform in both sexes; elytral striae very deep. *cricetus* Hausm.

Excavation in pygidial fold subcircular in male, subtriangular or subovate in female; elytral striae moderately to very weakly impressed. . . . . V.

V. Pygidium entirely rugose or punctate in both sexes; elytra decidedly short . . . . *amplipennis* Bend.

Pygidium smooth except for a finely rugulose basal band; elytra of normal length . . . *tenuestriatus* Fairm.

VI. Very small species: 8–9 mm. . . . . VII.

Moderate-sized to large species: 11–20 mm. . . VIII.

VII. Head impressed medially; clypeal carina interrupted and raised on either side . . . *impudens* sp. nov.

Head not impressed: clypeal carina interrupted but slender and not markedly raised . *infans* Klb.*

VIII. Elytral striae deep . . . . IX.

Elytral striae moderately to very lightly impressed. XI.

IX. Greater part of dorsal surface of pygidium punctato-rugose in male; stridulating bands narrow, very slightly divergent posteriorly . . . . . *dissidens* Pér.

Not more than half of pygidium rugose . . . . X.

X. Fifth stria on elytra very fine; fourth much abbreviated. *costatus* Lansberge.*

All elytral striae deep and coarse; fourth not abbreviated; stridulating bands slightly convergent anteriorly and posteriorly . . . . . . *angolensis* sp. nov.

XI. Carinae on head wanting . . . *densatifrons* Fairm.*

Frontal carina at least distinct . . . . XII.

XII. Clypeal carina obsolescent; frontal carina entire, biarcuate, retrosely angulate medially. . . . . XIII.

Clypeal carina distinct, but usually interrupted medially. XV.

XIII. Dorsal intervals of elytra more or less punctate.†
atratus Klug.*
Dorsal intervals of elytra impunctate. . . . . XIV.

XIV. Scutellum usually with a blunt impression; not more than one-third of pygidium closely punctato-rugose.
transvalicus Klb.
Scutellum not impressed; half or more of pygidium closely punctato-rugose in males . *obtusifrons* Fairm.

XV. Clypeal carina weak, but not clearly interrupted medially; pygidium slightly impressed beneath in male.
indotatus Pér.
Clypeal carina clearly interrupted medially; pygidium smoothly convex in male . . . . XVI.

XVI. Elytral striae very lightly impressed and shallowly punctate . . . . XVII.
Elytral striae firmly impressed . . . . . . XVIII.

XVII. Prothorax clearly punctate . . *abyssinicus* sp. nov.
Prothorax smooth or very obscurely punctate.
vix-striatus sp. nov.

XVIII. Dorsal intervals of elytra impunctate or with very faint punctures in the second; pygidium in female somewhat pointed and transversely subcarinate
consimilis Klb.
Second, fourth and sixth intervals of elytra more or less clearly punctate; ‡ pygidium in female smoothly convex . . . . XIX.

XIX. Elytral striae not or scarcely paired, stridulating bands markedly divergent apically . . . . *licas* Klug.
Elytral striae clearly paired; stridulating bands subparallel, very slightly divergent apically.
gerstaeckeri Klb.*

Group II. Clypeus with anterior margin tri-angulate.

I. Clypeus with anterior margin strongly reflexed and incurved on either side of median angle . . II.
Clypeus with anterior margin very weakly reflexed and not incurved on either side of median angle . XVI.

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† This distinction is not altogether reliable, but appears to be the only external one between *atratus* Klug and *obtusifrons* Fairmaire.

‡ Occasional specimens having the dorsal intervals quite smooth occur in species in which these intervals are normally punctate, e. g. *licas* Klug.

II. Marginal stria extending along entire basal margin of prothorax . . . . *foveolatus* sp. nov.
Marginal stria terminating in basal angles or extending for a short distance on either side along basal margin. III.

III. Anterior tibiae with an intermediate denticle . . IV.
Anterior tibiae without an intermediate denticle . IX.

IV. Stridulating bands broader towards the base and distinctly divergent apically . . . . V.
Stridulating bands little if any broader basally, subparallel or very slightly divergent apically . . VI.

V. Prothorax clearly but finely punctate . *andersoni* sp. nov.
Prothorax smooth or very obscurely punctate. *pygidialis* Klb.

VI. Pygidium with a broad punctato-rugulose basal band. VIII.
Pygidium smooth except for a very narrow aciculate or finely rugulose basal band . . . . VII.

VII. Clypeus and anterior portion of frons coarsely punctate; elytral striae deep . . . . . *rugifrons* Fairm.*
Clypeus and anterior portion of frons transversely rugulose; elytral striae moderately deep to shallow. *arator* F.

VIII. Prothorax finely but distinctly punctate over whole dorsal surface: 10–12 mm. . . . . . . *muticus* Bend.
Prothorax impunctate or obscurely punctate, chiefly at the sides: 8–9 mm. . . . . . . *tristis* Bhn.

IX. Head impressed medially, clypeal carina widely and completely interrupted and elevated on either side into a short transverse ridge . . . *parumpunctatus* Burm.
Head not impressed and clypeal carina not as described above . . . . X.

X. Elytral striae very strongly paired; very small species. *puerilis* Klb.*
Elytral striae not or comparatively slightly paired. XI.

XI. Basal one-half or more of pygidium rugulose; elytral striae distinctly, but not strongly paired. *congoensis* Klb.
Pygidium with greater part of surface smooth . XII.

XII. Clypeal carina slender and weak . . . . . . XIII.
Clypeal carina prominent . . . . XIV.

XIII. Basal rugulose band on pygidium moderately broad in both sexes; usual dorsal intervals punctate. *approximans* Klb.*
Basal rugulose band on pygidium usually very narrow in female but occupying about one fourth of the segment

in male; dorsal intervals usually, but not always impunctate . . . . *inops* Pér.

XIV. Stridulating rows moderately broad, straight, slightly divergent apically . . . . . . *simulans* sp. nov.

Stridulating rows narrow, slightly excurved in the middle, more or less divergent apically . . . . . . XV.

XV. Very small species: 8 mm. . . . . . . *beiranus* Pér.

Larger species: 10–11 mm. . . . *mosambicus* Pér.

XVI. Head not impressed; clypeal and frontal carinae obsolescent; very small species: 8·5 mm. *insignificus* sp. nov.

Head impressed medially; clypeal carina raised and widely interrupted in the middle . . . . . XVII.

XVII. Elytral striae little impressed and normally punctate. XVIII.

Elytral striae deeply impressed and coarsely punctate. *fossor* Reiche.

XVIII. Prothorax distinctly punctate, almost coarsely so in larger specimens: 9–14·5 mm. *puncticollis* sp. nov.

Prothorax mostly impunctate but slightly and very finely punctate anteriorly: 17 mm. *memnonius* Klb.

GROUP I.

Heteronychus flavopilosus Prell.

Ent. Mitt., iii, 1914, p. 198.

Black with underparts and appendages more or less castaneous; clypeus truncate anteriorly where margin reflexed and sharply bidentate; surface transversely rugulose, and somewhat plicate; frons with a number of somewhat transverse punctures anteriorly; surface of head generally glabrous; clypeal carina interrupted medially where there is a retrosely angulate depression or suture; frons depressed behind the clypeal carina; there is no sign of a frontal carina; prothorax attenuate gradually from back to front; anterior margin slightly prominent medially, anterior angles moderately prominent only; marginal stria extending very slightly past basal angles; surface of prothorax very weakly, indistinctly and sparsely punctate at the sides; scutellum ogival, impunctate and not impressed; elytra very slightly ampliate posteriorly; striae little impressed but clearly punctate; not distinctly paired;

second and eighth intervals with a straggling row of rather fine punctures throughout their length; fourth and sixth intervals with a few similar punctures in apical portion, tenth interval punctate in apical half; apices of elytra regularly and moderately closely pitted; propygidium finely and closely punctate; stridulating rows very narrow, almost straight, composed of very fine folds, very slightly coarser basally; the rows are several times their width apart at the base and are subparallel; pygidium little convex, impressed medially close to anal margin; coarsely rugose-punctate over whole surface; pygidial fold very narrow, but with a faint long narrow median impression which is very shallow and indistinct; several of the dorsal abdominal segments, including the propygidium, are ornamented at the sides with closely set yellow hairs; anterior tibiae with one intermediate and four basal denticles; sides of metasternum sparsely and somewhat vaguely punctate, not rugulose; ventral abdominal segments smooth, a few lateral setigerous punctures on the second and third.

17 mm. × 9 mm.

A female from Albany Museum, Grahamstown, Coll. Brady, rcd. 1904. Locality not stated (? Cape Colony).

The type of this species is also a single female from an unknown African locality, and no description of the male appears to have been published. This species presents certain characteristics which are not typical of *Heteronychus*, and its retention in the genus would appear to depend upon the form of the anterior tarsi of the male. The clypeus is a typical example of *Heteronychus* of the *licas* group, but the clypeal carina is peculiar in that it is very little, if at all, elevated above the surface of the clypeus, but is clearly marked behind by the depression of the anterior part of the frons. The complete absence of a frontal carina is not paralleled in any specimen of *Heteronychus* examined. Again the very slightly convex pygidium suggests some of the species such as *claudius* Klug and *camerunus* Kolbe, which have been removed from the genus. Finally the sides of the metasternum are not rugulose as in all other species of *Heteronychus*, but are smooth and shining except for a sparse and somewhat vague punctation. The yellow hair on the sides of some of the dorsal segments of the abdomen is also peculiar.

Heteronychus niger Klug.

Abhandl. Berlin Akad., 1855, p. 657.

(Plate XX.)

[Stated by Kolbe (Entomol. Nachrichten, No. 11, 1900, p. 165) to be a synonym of *rusticus* Klug from Madagascar, Abhandl, Berlin. Akad. Wiss., 1832, p. 166.]

Black; antennae, palpi, pectus and legs for the most part castaneous; clypeus broadly truncate in front, margin reflexed and bidentate; clypeus and anterior portion of frons weakly rugose; vertex of head smooth; head clearly impressed medially; clypeal and frontal carinae both widely interrupted and uniting on either side to form two prominent tubercles; prothorax with lateral margins subparallel in basal half curving thence gradually inward to anterior angles, marginal stria extending well round basal angles and for a short distance on either side along the basal margin; anterior margin with a slight median upward prominence behind which the dorsum is slightly but usually quite distinctly impressed; surface of prothorax smooth and shining but under a lens, × 16 diam., an extremely fine and obscure punctation may sometimes be distinguished in fresh specimens; elytra slightly ampliate in the apical two-thirds, weakly punctato-striate, second stria commonly very weak and often obsolescent basally; dorsal intervals subequal in width, the third and fifth being slightly narrower than the others, for the most part impunctate but the second, fourth and sixth may show a few small punctures and the eighth is usually irregularly punctate for the greater part of its length; stridulating bands very broad in the male, subparallel and consisting of very fine folds slightly coarser basally where the inner edges of the rows are contiguous; the rows taper gradually in width from base to apex, but they are still broad at the apical margin; in the female the rows are much narrower; pygidium smooth with a rugulose or shagreened basal band occupying about the basal third of the segment in the male, but much narrower in the female; in many specimens of either sex there is a median narrow abrupt transverse impression contiguous to the pygidial fold; pygidial fold broad in the middle, where there is a deep triangular excavation, the apex of the triangle being directed towards the anal margin; the fold is broader in the male than in the female and the triangular excavation more equilateral; anterior tibiae with one intermediate and three or more basal denticles.

18–20 mm. × 9–10 mm.

Natal (Durban), Moçambique, Transvaal (Lydenburg), S. Rhodesia (Salisbury), N. Rhodesia (Lake Bangweolo). Kolbe gives also Tanganyika Territory, Victoria Nyanza, "Nordufer," Bahr el Ghazal and Senegal.

This species is easily recognised by the faint knob on the anterior margin of the prothorax and the backward pointing triangular excavation in the pygidial fold.

As the writer has not seen any specimens of *rusticus* from Madagascar the name given to the African examples has been temporarily retained.

Heteronychus tenuestriatus Fairm.

Ann. Soc. Ent. Belg., 1893, p. 20.

(Plate XIX.)

H. wilmsi Klb. Entomol. Nachrichten, xxvi, 1900, Heft xi, p. 166.

H. infrictus Pér. Trans. S.A. Phil. Soc., xii, 1900, p. 517.

Black or castaneous; antennae, palpi, pectus and legs, for the most part ferrugineous; clypeus and frons as in *niger* Klug, but slightly more rugose; carinae similar, but tubercles slightly less prominent; prothorax similarly smooth or obscurely punctate, lateral margins subparallel for rather over half their length from the base and even very slightly contracted basally; marginal stria extending round basal angles and for a short distance on either side along the basal margin; elytra slightly ampliatc in posterior two-thirds; dorsal striae distinctly or indistinctly paired, moderately to very slightly impressed, the punctures somewhat shallow; second interval punctate or not, fourth and sixth usually with a moderately distinct series of punctures; eighth interval more or less strongly punctate throughout; apex of elytron closely foveolato-punctate; stridulating bands similar to those of *niger* Klug, but varying considerably in width irrespective of sex, though usually narrower in the females; pygidium smooth with a basal shagreened band occupying one-third, more or less, of the segment in the male and narrower in the female; pygidial fold broad in the middle with a deep subcircular or broadly oval excavation in the male, less broad in the female with the excavation triangular or subtriangular, the apex of the triangle directed away from the anal margin; occasionally the excavation is more or less fusiform in the female, but the inner margin of the fold is always excurved medially, which is not the case in the females of *niger* Klug (the

extreme variation noted in this direction is shown in the figure); anterior tibiae with one intermediate and three or more basal denticles.

14–19 mm. × 7–10 mm. Fairmaire gives 11–17 mm.

Natal (Durban, Malvern, Pinetown), Orange Free State, Transvaal (Lichtenburg, Lydenburg, Johannesburg), S. Rhodesia (Salisbury), N. Rhodesia (Mpika), Nyasaland, Kenya Colony, Uganda, Abyssinia, Angola.

Kolbe's types were from the Transvaal (Lydenburg) and Péringuey gives the additional localities of Cape Colony (E. London, St. John's River).

Through the kindness of M. Pierre Lesne the writer has been enabled to examine two male specimens identified by M. Benderitter as *tenuestriatus* Fairm. Both of these were collected in the present Kenya Colony in 1911 by Messrs. Alluaud and Jeannel. M. Benderitter, however, states that he has not seen the type of this species, the identification being made from the description only. Fairmaire makes no mention of the characteristic excavation in the pygidial fold, the multiplication of the basal denticles on the anterior tibiae nor of the broad stridulating bands on the propygidium, but otherwise his description fits the present species.

The distinction between *wilmsi* Klb. and *infrictus* Pér., which is also regarded as a synonym, rests only on such variable characteristics as the smaller size, depth of the elytral striae and the presence or otherwise of setigerous punctures on the ventral segments. The male genital armature of examples from Salisbury, which answer well to Péringuey's description of *infrictus*, is identical with that of examples from Lydenburg in the Transvaal, the home of Kolbe's types of *wilmsi*, and the same form is to be found throughout the series from the widely separated localities listed above. It is to be expected that a widely distributed species such as this should exhibit considerable variation, but *tenuestriatus* appears to be more than usually variable as regards the depth of the elytral striae, showing greater differences in this respect than are to be found in the equally widely distributed *licas* Klug, as an instance. The differences are, however, graduated from the typical *infrictus* from Salisbury to the typical *wilmsi* from the Transvaal.

Compared with the Transvaal specimens those from

Mashonaland, N. Rhodesia and Nyasaland are rather small (14–16 mm.) with the elytral striae very weak, the stridulating bands narrower, and the ventral segments lacking or with comparatively few setigerous punctures. Most of the Natal specimens approximate this type but are larger (14–19 mm.), the elytral striae are rather firmer, and the stridulating bands similar. The number of setigerous punctures on the ventral segments varies from very few to a moderate series. Even the largest of the Natal series have markedly weaker elytral striae than the Transvaal examples and very few setigerous punctures on the venter. A single female from the Orange Free State measures 17 mm., the elytral striae are nearly as deep as the Transvaal representatives, the stridulating bands are moderately broad, and there is a row of setigerous punctures on the two basal visible segments of the venter, a few on the third and none on the fourth. All the Transvaal specimens are moderately strongly striate and more or less typical *wilmsi*, but the setigerous punctures on the venter vary considerably in number. The Angola examples (2 males and 3 females) are like those from the Transvaal, but mostly with the elytral striae weaker. The examples from Kenya (3 males and 8 females) measure 14–17 mm. and show all degrees or impression of the elytral striae. It is noteworthy, however, that in the Kenya examples alone, the usual pairing of the elytral striae is not always evident.

Heteronychus amplipennis Bend.

"Voy. de Ch. Alluaud et R. Jeannel en Afrique Orientale," 1911–12, Ins. Col., xii, 1915, p. 390.

(Plate XIX.)

Black; pectus, palpi, antennae and tarsi somewhat castaneous; clypeus truncate anteriorly, margin reflexed and sharply bidentate; surface of clypeus and anterior portion of frons somewhat finely rugulose; clypeal and frontal carinae united on either side, somewhat raised and completely interrupted medially; frons slightly impressed medially behind the carinae; prothorax attenuate practically from the base, the surface glabrous but clearly and regularly, though finely and somewhat sparsely, punctate; marginal stria terminating in basal angles; scutellum impunctate, with a

very faint median longitudinal impression; elytra short, ampliate practically from the base; striae clearly paired, little impressed but clearly punctate, the fourth and fifth somewhat abbreviated in the female specimen; the second interval is impunctate in both specimens, the fourth and sixth also in the male, but in the female these intervals show a number of somewhat shallow punctures; the eighth interval is subseriate-punctate in both specimens; stridulating bands on pygidium broad and composed of very fine folds scarcely coarser basally, where the bands are subparallel, inner edges almost contiguous basally; the bands taper apically but are still broad near the apical margin; pygidium more than half rugulose-punctate in the male and the apical smoother area is sparsely punctate; in the female the rugulose band is narrower, but there are some scattered punctures over the whole segment; pygidial fold very greatly ampliated medially in both sexes, with a broad subcircular excavation in the male; in the female the excavation is quite as broad but more subovate transversely; anterior tibiae with one intermediate and two basal denticles.

Length 12–13·5 mm.; width 6·5–7 mm. M. Benderitter gives Long. 12–14 mm.

Kenya Colony, open plains S.W. slope of the Aberdare Mountains, alt. 2,600–2,700 metres; Feb. 1912 (*Coll. Alluaud and Jeannel*).

The male and female specimens described above were kindly presented by M. P. Lesne of the Paris Museum. This species obviously falls into the little subgroup with *niger* Klug, *tenuestriatus* Fairm. and *cricetus* Hausm. It is readily recognised by the shortness of the elytra and the fact that the pygidium is punctate to the apex.

Heteronychus cricetus Hausm.

Magazin f. Insektenkunde von Illiger, 6 Bd. 1807, p. 266.

(Plate XX.)

H. indigus Pér. Trans. S.A. Phil. Soc., xii, 1900, p. 519.

Black, antennae, palpi, pectus and femora in part castaneous or ferrugineous, tibiae for the most part black; clypeus truncate in front, margin reflexed and bidentate; head, except vertex, obliquely rugose, impressed medially; clypeal carina obsolescent; frontal carina widely interrupted and produced on either side of median depression into a small tubercle similar to but hardly as

prominent as that of *tenuestriatus* Fairm., prothorax smooth or obscurely punctate, more clearly at the sides, lateral margins subparallel in basal half; marginal stria only just reaching the basal angles; scutellum impunctate; elytra ampliate in apical two-thirds, deeply striate, the striae closely punctate and not very conspicuously paired; the dorsal striae are unusually complete basally where they are slightly turned inwards; the second interval is impunctate or shows a few indistinct points, the fourth may show a number of clear punctures or be entirely smooth, the sixth is usually more or less punctate and in some specimens shows an oblique furrow running forward from near the base of the sixth stria to the fifth; the eighth interval shows a straggling series of punctures; stridulating bands consisting of very fine folds, rather coarser basally; bands very broad, subparallel, contiguous basally and separated by a very narrow space apically; pygidium smooth with a narrow punctate basal band in the male and punctate lateral angles; the punctate basal band is commonly obliterated medially in the female, but the angles are more or less punctate; pygidial fold with a median transverse more or less fusiform excavation; anterior tibiae with one intermediate and one basal denticle in the male, but two or three basal denticles in the female.

14·5–18 mm. × 8–10 mm.

Cape Province (Capetown, George, Uitenhage, Bedford).

Prof. Kolbe's description of *cricetus* Hausm. (Entomol. Nachrichten, xi, 1900, p. 165) leaves no·doubt that this species is indicated. The almost smooth pygidium probably led to its original confusion with *arator* F. A female specimen in the writer's collection was identified by Dr. Péringuey as *indigus* Pér.

Since writing the above the writer has received a letter from Dr. Péringuey in which he volunteers the information that *cricetus* Hausm. is a good species. He also kindly forwarded a male specimen which is a typical example of the species described above.

Heteronychus licas Klug.

Erman. Reis, Atlas, p. 35.

(Plate XVIII.)

H. corvinus Klug. Monatsber. Akad. Wiss. Berlin, 1855, p. 657 (*fide* Kolbe).

H. curtipennis Fairm. Ann. Soc. Entomol. Belge, 1894, p. 315 (*fide* Péringuey).
H. mashunus Pér. Trans. S.A. Phil. Soc., xii, 1900, p. 519.

Black, antennae, palpi, pectus and tarsi for the most part castaneous; clypeus truncate in front, margin reflexed, bidentate; surface of clypeus and anterior portion of frons obliquely rugulose, vertex smooth; clypeal carina distinct, slightly elevated, and more or less interrupted, usually more widely in the female than in the male; frontal carina touching clypeal on either side of interruption and usually traceable medially as a very slender line slightly curved backward or subangulate; prothorax apparently smooth, but in many specimens very finely and obscurely punctate, the punctures being most easily detected towards the lateral margins; lateral margins subparallel or convergent apically in basal two-thirds, marginal stria just passing basal angles; scutellum impunctate with a median longitudinal impressed line in both sexes, but this is frequently obliterated irrespective of sex; elytra ampliate in apical three-fifths, striae usually firm and closely punctate, intervals usually subequal in width, but striae sometimes weakly paired; second, fourth, sixth and eighth intervals more or less punctate; stridulating bands narrow and tapering from base to apex, folds much coarser and more widely set in basal half, where the rows are about twice their width apart and subparallel; in apical half the rows diverge strongly and are slightly incurved at apical margin; pygidium with a strongly punctato-rugose basal band occupying half the segment in the male and rather less in the female; in the latter sex the band is in general less closely punctate than in the male and narrower in the centre than at the sides; pygidial fold broader in the male than in the female, but not impressed; anterior tibiae with one intermediate and one basal denticle.

11·5–19 mm. × 6–9·5 mm.

Natal, Zululand, Moçambique (Beira), Transvaal (Lydenberg, Waterberg), S. Rhodesia (widely distributed and a common pest), N. Rhodesia (Livingstone), Nyasaland, Nubia, West Africa (Congo).

Klug's types were from Senegal and those described under *corvinus* from Tette, P.E.A. Boheman gives Limpopo River, Kolbe Tanganyika Territory, and Péringuey Mocambique (Lourenzo Marques).

With reference to the writer's opinion that *mashunus* Pér. is a synonym of *licas* Klug, it is necessary to draw attention to the fact that Dr. Péringuey has published

figures of the male genitalia of both *licas* and *mashunus* (Trans. S.A. Phil. Soc., xii, figs. 2 and 4) and that these figures appear quite distinct. The writer has, however, dissected a large number of males from Rhodesia and the East Coast and one from the West Coast, and the genitalia certainly belong to one species only. They do not, however, appear to correspond exactly with either of Péringuey's figures. Dissected males from S. Rhodesia forwarded to Dr. Péringuey were identified as *mashunus* Pér.

Specimens of this species from S. Rhodesia vary very greatly in size but on the average are smaller than those from the East Coast. In a very extensive S. Rhodesian series the males vary from 11·5–16·5 mm. and the females from 13–19 mm. A male from Livingstone (N. Rhodesia), however, measures fully 18 mm. East Coast males vary from 14·5–18 mm. and the females from 17–19 mm. A male from the West Coast (Congo) is a typical *mashunus* Pér. of 15 mm. Another male, simply labelled "W. Africa," measures 17 mm. and a female from Senegambia 17·5 mm. Two specimens from Nubia are rather larger (17 and 19 mm.).

Heteronychus gerstaeckeri Klb.

Entomol. Nachrichten, No. 11, 1900, p. 168.

"(H. atratus Gerstaecker *nec* Klug in v.d. Decken's Reisen in Ost Afrika, III. Bd. Gliederthiere S. 118; Kolbe in Stuhlmann's Ost Afrika, IV. Bd. S. 160)."

Translation of author's description and notes:—

"This species was taken by Gerstaecker (*l.c.*) for *H. atratus* Klug, which comes from Moçambique. It is, however, distinguished from all its allies through the following characteristics. The head is more weakly wrinkled, although the epistome is similarly formed. The prothorax is shorter, the dorsal surface smooth, at the sides very weakly and hardly visibly punctate. The striae on the elytra which are similar in form, are deeper, the third, fifth and seventh intervals much narrower than the fourth and sixth; in *atratus* all the intervals are practically equal. The pygidium is moderately and smoothly convex without the projecting transverse ridge. The two stridulating rows of the propygidium are almost parallel, weakly divergent posteriorly; in *atratus* they are strongly divergent behind and markedly convergent in front.

"Characteristics of the species:—Piceous black, elytra piceous, antennae, palpi and tarsi castaneous; epistome attenuate, obtuse in front, bidenticulate with the teeth reflexed; prothorax transverse, moderately shining, smooth, very finely and sparsely punctulate at the sides with the punctures scarcely visible; anterior angles short, distinct, posterior angles obtuse; elytra moderately impresso-striate, striae deeply "striate,"* intervals impunctate, third, fifth, and seventh much narrower than fourth and sixth respectively, hinder part of ninth and apex of elytron irregularly punctate; pygidium convex, basal half rugose, dull, apical half smooth and shining; stridulating rows of the propygidium almost parallel, slightly divergent posteriorly.

Length of body 15 mm.

"One example, a female from the Zanzibar Coast, taken in the spring of the year 1865 (v.d. Decken), No. 70318."

Heteronychus vix-striatus sp. nov.

(Plate XX.)

Black; antennae, palpi, and pectus ferrugineous, legs for the most part castaneous; clypeus truncate anteriorly, margin reflexed and bidentate; head except vertex transversely rugose, slightly depressed behind the carinae; clypeal carina distinct, elevated, interrupted in the middle; frontal carina distinct laterally, biarcuate but somewhat indistinct medially; prothorax with sides subparallel or slightly convergent apically in basal two-thirds; surface apparently impunctate; lateral stria extending round basal angles and half-way to the centre along the basal margin; scutellum impunctate and very weakly if at all impressed medially; elytra rather long and scarcely ampliate posteriorly, very weakly punctato-striate, striae hardly impressed but strongly paired, punctures very small and shallow; the broader intervals mostly show a few indistinct punctures; stridulating bands considerably broader with coarser folds in basal half, where they are approximated; they are more or less straight and diverge at a moderately wide angle to the apical margin; pygidium, with basal one-third closely punctate in male, is entirely smooth in the female except for a few scattered coarse punctures towards the basal margin; in the

* The Latin text reads "elytris sat impresso-striatis, striis profunde *striatis*," which does not appear to contain a very definite meaning and is, in fact, in part contradictory; it appears probable the second "striatis" was printed in mistake for "punctatis."

latter sex the pygidium is also slightly impressed medially beneath; pygidial fold narrow and not impressed; anterior tibiae with one intermediate and one basal denticle.

14–15 mm. × 7–7½ mm.

Transvaal (Piet Retief), Natal (Durban), Cape Province (loc. ?).

This species might conceivably be that described by Fairmaire under the name of *laevilineatus* of which the type specimen hails from Moçambique, but the description of the latter is altogether inadequate to allow of a positive identification being made.

Heteronychus lævilineatus Fairm.

Ann. Soc. Entom. Belg., 1894, p. 315.

Translation of author's description (from Péringuey) :—

"Very similar to *H. punctolineatus*, but a little smaller, and especially more slender; vertex not impressed; prothorax narrower, less narrowed in front; elytra similarly finely striate with the striae smooth and with very smooth punctures at the base; stridulating apparatus not conspicuous.

"This species seems to be allied to *H. atratus* Klug from Moçambique, but this last-named species is only 13 mm. long, the elytra have deep punctures, the fifth and sixth rows are obliterated behind and do not go much beyond the median part of the elytra, the intervals are smooth, the second and eighth alone having a few not very well-marked punctures, the pygidium is marginate and wrinkled except the apical part which is smooth.

"*Hab.* Mozambique."

This is the most unsatisfactory description with which the writer has had to deal. *H. punctolineatus* Fairm. is an Oriental species from Cochin China and the very cursory description published is a comparison with a third species of the same author, namely *interruptus*. The description of the latter concludes with the statement that the anterior claws of the *male* are equal and moderately slender (!!!). The chief characteristics of *interruptus* consist in the slight transverse impression of the frons, the interrupted and slightly bituberculate clypeal carina, biangulate front margin of the clypeus, smooth or obscurely punctate prothorax, elytra scarcely ampliated behind and strongly

punctato-striate, a few punctures on the two broader dorsal intervals, pygidium with a moderately wide, strongly punctate basal band, the anterior tibiae with one intermediate and several basal denticles. Length 14–17 mm. *H. punctolineatus* is stated to be closely allied, only differing in respect to the elytral striae, which are scarcely marked, except the sutural (? juxta-sutural), the slightly more truncate clypeus, the wider scutellum, the wider and more densely punctate basal band on the pygidium and the still smoother prothorax. The size is not given, and is presumably similar to that of *interruptus*.

H. laevilineatus would thus appear to be a slender species with a sub-bituberculate clypeal carina, unimpressed frons, very fine smooth elytral striae with a few punctures on the dorsal intervals, stridulating rows indistinct, a wide punctate basal band on the pygidium, and one intermediate and possibly several basal denticles on the anterior tibiae. The description appears to be altogether inadequate for recognition, in fact *interruptus*, which forms the real basis of the description, would appear not to be a true *Heteronychus* at all.

Heteronychus abyssinicus sp. nov.

(Plate XVIII.)

Black, shining; pectus and appendages for the most part castaneous; clypeus truncate anteriorly, margin reflexed and bisinuate; dorsal surface transversely rugulose; anterior portion of frons scrobiculate-punctate; clypeal carina prominent, interrupted medially; frontal carina entire, touching clypeal on either side and retrosely angulate in the middle; prothorax with margins subparallel in basal half thence roundly attenuate to anterior angles which are somewhat blunt, whole surface finely but clearly punctate, the punctures being coarser towards the anterior angles, marginal stria terminating in basal angles; scutellum impunctate and not impressed; elytra slightly ampliate in apical three-quarters; elytral striae very shallow and indistinctly punctate, not paired, fourth stria much abbreviated; dorsal intervals impunctate and only a few shallow punctures in apical portion of eighth; stridulating bands narrow, even in width, but with coarser folds basally, slightly divergent posteriorly for about one-third of their length from the base, thence diverging at a wide angle to the apical margin where they are slightly incurved; pygidium smooth with a very

narrow punctato-rugulose basal band; pygidial fold narrow and simple; anterior tibiae with one intermediate denticle and the margin angulate above the basal tooth.

11 mm. × 6 mm. (male).

Abyssinia.

This little species is easily recognisable by the form of the clypeus, the punctate prothorax, the very weakly striate elytra and the nearly smooth pygidium. Its nearest relative would appear to be *vix-striatus* m.

Heteronychus consimilis Klb.

Entomol. nachrichten, No. 11, 1900, p. 168.

(Plate XX.)

H. pauperatus Pér. Trans. S.A. Phil. Soc., xii, 1900, p. 523.

H. nitidus Bend. "Voy. d. Ch. Alluaud et R. Jeannel en Afrique Orientale," 1911–12, Ins. Col. XII, Scarabaeidea, p. 391.

Very similar to S. Rhodesian examples of *licas* Klug, black, shining; antennae, palpi, pectus and in part the legs ferrugineous; clypeus weakly rugose, truncate anteriorly with margin reflexed and bidentate; frons smooth except close to carina, where it is weakly rugulose transversely; clypeal carina somewhat ill-defined in front of the eyes, but clear, straight and raised in the intermediate area and moderately broadly interrupted in the centre; frontal carina distinct, very fine, touching or coalescing for a short distance with clypeal on either side of interruption and forming a strong backward directed angle in the centre; prothorax gradually attenuate from back to front, apparently impunctate or very obscurely punctate, marginal stria terminating in posterior angles; scutellum impunctate, broadly and shallowly impressed; elytra hardly ampliate posteriorly, the striae indistinctly paired, for the most part firmly impressed and closely punctate; the second stria is less firmly impressed and rather obsolescent basally especially in the female, whilst the basal fifth of the sixth stria is altogether obliterated; dorsal intervals impunctate but sometimes a few punctures in the basal part of the sixth; eighth interval more or less punctate, especially apically; stridulating rows narrow, rather broader basally where the folds are coarser and the rows approximated, straight or somewhat excurved in apical half, more or less strongly divergent to apical margin where rows frequently

lightly incurved; rows slightly narrower and weaker in female; pygidium smooth with a closely and coarsely punctate or scrobiculate basal band occupying rather less to rather more than a third of the segment in the male, slightly narrower in the female; in the latter sex the band is still narrower medially where the punctures are much coarser and less closely set; in the female the pygidium is also subcarinate transversely in the middle of the segment and usually slightly impressed beneath; pygidial fold narrow and simple, anterior tibiae with one intermediate and one basal denticle.

14–16 mm. × 7–8 mm.

Benderitter gives the dimensions of *nitidus* as from 18–20 mm.

S. Rhodesia (Salisbury, Gwelo, Somabula, Lalapanzi), Abyssinia, Tanganyika Territory (*f. Kolbe*), Kenya Colony, Nairobi and Mbuyuni (*f. Benderitter*).

The type specimens consist of two females in the Berlin Museum. Dr. Walther Horn of the Deutches Entomologisches Museum very kindly compared specimens from S. Rhodesia with the types and pronounced them indubitably to belong to the same species. Two males from Abyssinia (Raffray) in the British Museum collection show a strongly marked oblique furrow in the basal part of the sixth elytral interval, practically joining the basally abbreviated sixth stria to the fifth. This furrow is not so clearly developed in any of the series of Rhodesian specimens although there are distinct traces of it in individuals. It may be mentioned that a similar furrow may or may not be present in *cricetus* Hausm., so that its presence or otherwise can hardly be regarded as of specific value. The male genital armature in the Abyssinian specimens is also slightly different, in that the intermediate outward projection is angulate rather than rounded, but this peculiarity is approached by at least one of the series from S. Rhodesia. There appears to be no justification, therefore, for regarding the Abyssinian specimens as distinct.

Through the courtesy of M. Pierre Lesne the writer has been enabled to examine a male co-type of *nitidus* Bend., from which the genital armature had unfortunately been removed. M. Benderitter, however, very kindly compared male and female specimens from S. Rhodesia with his types and pronounced the genital armature to be similar, and although the size of *nitidus* is greater he considered the

specimens undoubtedly conspecific. It should be mentioned that the specimen of *nitidus* lent to the writer measured only 16·5 mm. at the outside.

Heteronychus transvalicus Klb.

Entomol. Nachrichten, No. 11, 1900, p. 167.

(Plate XVIII.)

?*H. indotatus* Pér. Trans. S.A. Phil. Soc., xii, 1900, p. 520.
H. viator Pér. Trans. S.A. Phil. Soc., xii, 1900, p. 522.

Black; antennae, palpi, pectus, legs, etc., ferrugineous or castaneous; clypeus truncate anteriorly, margin reflexed, bidentate; head except vertex reticulo-rugose and somewhat plicate transversely; clypeal carina more or less obsolescent, when present interrupted medially; frontal carina distinct, entire, biarcuate, retrosely angulate medially, prothorax attenuate gradually from back to front, smooth or obscurely punctate; marginal stria extending slightly past basal angles; scutellum impunctate with a short blunt median impression (occasionally wanting); elytra ampliate practically from the base, striae weakly to moderately impressed and weakly punctate, not paired, fourth and fifth somewhat abbreviated, sixth obsolete in basal one-fourth, dorsal intervals impunctate, eighth interval more or less punctate in apical half, stridulating bands narrow, slightly broader basally where the folds are coarser and the rows approximated; the latter are slightly divergent in the basal half, much more strongly in the apical half, and are slightly incurved at the apical margin; pygidium smooth with a coarsely punctate basal band, very weak medially and occupying about one-third of the segment; in the female the pygidium is usually subangulate transversely with an impression beneath; pygidial fold rather broader in male than female and not impressed; anterior tibiae with one intermediate and one basal denticle.

13–16 mm × 7–9½ mm.

Transvaal (Johannesburg, Pilgrim's Rest), Cape Colony (Capetown), Natal (Maritzburg). Péringuey gives Transvaal (Potchefstroom) and Natal (Newcastle, Durban); Kolbe's types were from Transvaal (Lydenburg).

The occurrence of this species at Capetown is rather surprising, but there is a specimen in the British Museum collection bearing this label, the collector's name being J. G. Cregoe.

This seems to be a common and widely distributed species in the South African Union. There appears little doubt that *transvalicus* Klb. and *viator* Pér. are synonymous, as some of the specimens examined answer exactly to Prof. Kolbe's description and accompanying remarks, whilst there is no doubt from the male genitalia and general description that this is the species described by Péringuey. It should be noted, however, that in many specimens the clypeal carina is almost completely suppressed, and, therefore, the median interruption mentioned by Prof. Kolbe is not apparent (Kolbe does not distinguish between the clypeal and frontal carinae). Such specimens cannot be recognised with certainty from Prof. Kolbe's description, and but for the help of a considerable series the writer would undoubtedly have followed Dr. Péringuey in failing in this respect.

The question of *indotatus* Pér. being a synonym of this species is discussed after the description of the type specimen of *indotatus*, which follows.

Heteronychus indotatus Pér.

Trans. S.A. Phil. Soc., xii, 1900, p. 520.

(Plate XIX.)

Black, shining; pectus and appendages more or less castaneous; anterior margin of clypeus truncate, reflexed and bisinuate, not dentate; surface of clypeus and anterior portion of frons transversely rugulose; clypeal carina weak, almost indistinguishable laterally, hardly interrupted medially; the frontal carina is distinct and does not coalesce with the clypeal; it is biarcuate with a basally directed median angulation; prothorax broad, attenuate practically from the base; surface minutely and obscurely punctate, marginal stria extending slightly past the basal angles; scutellum punctate with a blunt median impression; elytra no wider than the prothorax at the base, little ampliate posteriorly, very weakly striate, the punctures small and somewhat indistinct, fourth and fifth striae much abbreviated, sixth obsolete in basal third but continued deeply right to the apex where it joins the second; striae not paired and dorsal intervals impunctate; stridulating bands broader with coarser folds basally and strongly divergent in apical half (similar to those of *licas* Klug); pygidium smooth with a punctato-rugulose basal band occupying nearly half the

length of the segment at the sides, but almost interrupted medially, where it consists only of a few uneven-sized punctures; the surface is not, as is usual in male *Heteronychus*, smoothly convex, but is flattened medially in the lower half, the impression also interrupting the convex outline when the segment is viewed from above; pygidial fold simple; anterior tibiae with one intermediate and one basal denticle.

Male: length 15 mm.; width 8·25 mm.

Stated by Péringuey to be from Transvaal (Potchefstroom).

The specimen described above is the type kindly lent by Dr. Péringuey.

This specimen presents some very puzzling features. The genital armature suggests an aberrant example of *transvalicus* Klb. (= *viator* Pér.), much narrower than usual in the apical portion, but identical basally; the shape of the frontal carina and partial suppression of the clypeal, the blunt impression on the scutellum, the feeble striation of the elytra and impunctate intervals, the stridulating bands, and the rugulose basal band of the pygidium are also more or less similar to *transvalicus*. The peculiar shape of the pygidium is unparallelled in any male I have seen hitherto. It is exactly the shape of a female *arator* F. and some allied species. Finally the subparallel sides of the elytra are unlike *transvalicus* which is markedly broader behind.

The specimen does not look in any way deformed but its establishment as a good species would appear to depend upon the discovery of further examples. It is noteworthy that similar specimens are not to be found in any of the other museums in S. Africa, although Potchefstroom is, of course, a populous district. For the present the writer is inclined to regard this specimen as an aberrant *transvalicus* Klb.

Heteronychus obtusifrons Fairm.

Ann. Soc. Ent. Belg., 1893, Vol. 37, p. 19.

(Plate XIX.)

Black, including for the most part pectus and legs; antennae, palpi and bristles, etc., ferrugineous, apices of elytra rufopiceous; anterior margin of clypeus truncate, reflexed and bluntly bidentate;

head weakly and transversely rugose; clypeal carina almost obsolete, but frontal carina distinct, entire and biarcuate, retrosely angulate medially; prothorax extremely finely and obscurely punctate, the punctures being hardly distinguishable even under a lens × 16; lateral margin very slightly constricted posteriorly or subparallel in basal half; marginal stria ending in posterior angles and very deep laterally, especially towards anterior angles; scutellum impunctate and not impressed; elytra with dorsal striae not or only slightly paired, lightly to moderately or even deeply impressed, except the second which is frequently very weak and nearly or quite obsolete for a short distance basally; fourth and fifth striae frequently much abbreviated; punctures in the striae for the most part small and shallow, and not always distinct; lateral striae weak except basally; intervals impunctate, except the eighth, which shows a small series of punctures apically; (a single female from Nairobi, however, which appears to belong to this species shows a number of distinct punctures on the second interval, a few indistinct on the fourth, and the eighth is punctate over the greater part of its length;) stridulating bands narrow, coarser and slightly wider basally where the rows are subparallel, very strongly divergent in the apical half, the rows being slightly incurved at the margin; pygidium simply convex in the male with the basal half or more closely and thickly punctate, in the female subcarinate transversely and abruptly convex from side to side, the basal third punctate with the punctures much sparser in the middle; pygidial fold simple; anterior tibiae with one intermediate and one basal denticle.

12–16·5 mm. × 7–9 mm.

Kenya Colony (Narok, 5,000 ft., *A. C. Luckman*; Masai Reserve, do., Londiani, Nairobi; Kikuyu Escarpment, 6,800–7,400 ft., *S. A. Neave*); Tanganyika Territory (Usangu Dist., 3,500–4,500 ft., *S. A. Neave*); Abyssinia. Twenty-eight specimens.

Recorded also by Benderitter from Kenya Colony (*Coll. Alluaud and Jeannel*), and by Kolbe from Tanganyika Territory (Die Kafer Deutsch Ost Afrikas).

This species is very similar to *transvalicus* Klb., but the male genitalia are somewhat different, the basal punctate band on the pygidium is considerably broader in the E. African species, and in *transvalicus* the scutellum is commonly very characteristically impressed.

The writer is indebted to M. Pierre Lesne for kindly

forwarding a pair of specimens of this species from Kenya, identified by M. Benderitter.

Kolbe apparently mistakenly places *obtusifrons* Fairm. in the group with *arator* F., possibly on the basis of Fairmaire's statement that it is very like that species.

It is obviously common in East Africa, but has not yet been recorded south of the Zambesi River. There appears to be a distinct possibility, however, of this species being the same as *atratus* Klug, the only external difference being apparently the presence in the type of that species of punctures in the dorsal intervals on the elytra, an unreliable characteristic.

Heteronychus atratus Klug.

Monatsber. Berl. Acad., 1855, p. 657; Peters. Reis., 1862, p. 253.

Translation of author's description and notes (from Péringuey) :—

"Black; antennae and legs ferrugineous, head rugose; clypeus obtuse, marginate, frontal line subinterrupted in the centre; prothorax smooth, subglobose; elytra striate, closely punctate at apex, intermediate striae abbreviated. Female: length 6½ lin.

"A single example from Tette. Deep black, not shining, of the size and form of *H. arator*; antennae and dorsal joints brown; head weakly rugose, clypeus marginate and with the apex reflexed, between the eyes there is a curved ledge, which is scarcely interrupted in the middle; prothorax smooth; on the elytra are rows of impressed punctures of which the fifth and sixth * are abbreviated, and do not reach far beyond the median part of the elytra; apex densely punctate, intervals smooth, but with some indistinct impressed punctures in the second and eighth; pygidium marginate and rugose with the exception of the apex which is smooth."

In addition to the above we have some further particulars supplied by Prof. Kolbe when differentiating between *gerstaeckeri* Klb. and this species. These indicate that in *atratus* the elytral striae are not very deep and are not paired, the stridulating bands are strongly divergent

* It is the fourth and fifth elytral striae which are usually abbreviated in this genus.

posteriorly and the pygidium in the female is transversely subcarinate. Dr. Walther Horn, who kindly examined the type specimen in the Berlin Museum on the present writer's behalf, states also that the carinae on the head are similar to those of *obtusifrons* Fairm., the clypeal carina being partly suppressed and the frontal carina biarcuate. It would appear, therefore, that the only external distinction between this species and *obtusifrons* Fairm. lies in a few not very well marked punctures in the second interval of the elytra. A female specimen from Kenya in the British Museum was judged by the present writer to belong to the same species as a long series of *obtusifrons* from East Africa, although the dorsal intervals are clearly punctate, as this character is not absolutely constant.

Prof. Kolbe records *atratus* Klug from the present Tanganyika Territory (Die Kafer Deutsch Ost Afrikas), but Dr. Horn informs the writer that at the Berlin Museum Prof. Kolbe had confused some other species with *atratus*, after the removal of which the type alone was left, so that at the present time the single female would appear to be the only authentic *atratus* extant.

Heteronychus dissidens Pér.

Trans. S.A. Phil. Soc., xii, 1900, p. 523.

(Plate XX.)

Black; antennae, palpi, pectus and in part the legs, ferrugineous or castaneous; clypeus truncate anteriorly where margin reflexed and bidentate; head except vertex obliquely rugose; clypeal carina distinct, raised and medially interrupted; frontal carina also distinct, entire and bi-arcuate, touching clypeal on either side of median interruption; prothorax with lateral margins more or less subparallel in basal three-fifths, marginal stria terminating in basal angles; surface of prothorax finely and sparsely punctate, rather more clearly in basal angles; scutellum impunctate with a longitudinal median impression; elytra slightly ampliate in apical two-thirds, deeply striate with punctures in striae inconspicuous; striae hardly paired; second, fourth and sixth intervals may be distinctly punctate or nearly smooth, eighth interval distinctly punctate; stridulating bands very narrow, folds hardly coarser basally; bands well apart basally and very slightly divergent in basal three-quarters, more abruptly divergent in apical quarter and slightly incurved at margin; pygidium in male may be almost

entirely punctato-rugose, but a small apical area is usually more or less smooth; in the female the pygidium is subcarinate transversely, the carina slightly arcuate medially with a distinct impression beneath, the greater part of the surface above the carina closely punctato-rugose and the surface beneath smooth; pygidial fold broader in the male than female, but not impressed; anterior tibiae with one intermediate and one, sometimes more than one, basal denticle.

12–13 mm. × 6–6½ mm.

S. Rhodesia (Salisbury), Nyasaland (*S. A. Neave*).

The elytral striae in this species are unusually deeply impressed, and this in conjunction with the almost entirely punctato-rugose pygidium in the male serves to distinguish the species. Its nearest ally appears to be the new species *angolensis* m.

Heteronychus costatus Lansberge.

Notes Leyden Mus., viii, 1886, p. 105.

Translation of author's description:—

"Altogether black, shining; clypeus truncate, frontal carina biarcuate, thorax smooth, elytra deeply and irregularly striate. Length 14 mm.

"Of the form of *H. arator* F. and *plebeius* Klug, but with the elytra much more deeply striate. Little convex, shining, entirely black both above and beneath, with several brown patches on the pectus and the legs. Head rugose, clypeus marginate and truncate in front, entire, separated from the frons by a carina formed by two little arcs of a circle, which join in the middle forming a backward projection. Thorax altogether smooth, scutellum the same; elytra wider than the prothorax, ornamented with deep striae, except one, of which the second and third, the fifth and sixth, and the eighth and ninth are respectively approximated, the fourth alone very slender, the intervals smooth, the second very wide, attenuate towards the apex, the fourth also very wide but parallel joining the third behind, having a deep stria in the first half, the seventh interval punctate, the apex covered with a coarse punctation in which the striae are submerged. Pygidium rugose at the base, transversely swollen in the middle, anterior tibiae tridentate, the second tooth very small.

"Humpata, Angola."

There appears to be little doubt that the apparently peculiar arrangement of the elytral striae in the above description is due to a misconception on the part of M. Lansberge. It would seem that the "deep stria" in the front half of the so-called fourth interval is in reality the much abbreviated fourth stria, that the elytral striae are, therefore, normally paired, *i. e.* 2–3, 4–5, 6–7, etc., and that the striae beyond the third and the intervals beyond the fourth are all numbered one short. We are confronted then with a very black species belonging to the *licas* group with a biarcuate carina on the head, impunctate prothorax, deep-paired elytral striae (the fifth stria being much less deep than the remainder), fourth stria abbreviated, impunctate intervals, pygidium rugose at the base, and transversely subcarinate medially (obviously a female). The reduction of the 2nd tooth on the anterior tibiae strongly suggests a much-worn specimen, in which any denticles might be obliterated. Except for the abbreviation of the fourth elytral stria and the slenderness of the fifth the description more or less fits the new species *angolensis*, and it is quite possible that the species are identical.

Heteronychus angolensis sp. nov.

(Plate XXI.)

Black, including for the most part pectus and legs; palpi, antennae, bristles, etc., ferrugineous; front margin of clypeus truncate, reflexed (the type is a little worn and the reflexed margin is not bidentate); head transversely rugose to the front of the eyes, above this smooth; clypeal carina indistinct, interrupted medially but frontal carina entire and biarcuate; prothorax with lateral margins subparallel in basal half, apparently impunctate; marginal stria very slightly passing the rounded basal angles; scutellum impunctate with a median impression; elytra rather short, very slightly ampliate posteriorly; striae deep with the punctures somewhat confluent, scarcely paired; the sixth stria is obsolete in the basal fourth and scarcely punctate, but continued very deeply and conspicuously right to the apex, where it joins the second; intervals impunctate except the eighth which has a few punctures apically; stridulating rows narrow, folds coarser basally where the rows approximate, divergent for rather more than two-thirds of their length then slightly convergent in the apical third; basal

half of pygidium closely punctate; pygidial fold simple; anterior tibiae with one intermediate and one basal denticle.

12 mm. × 6 mm.

A single male from Angola (somewhat worn).

This species may be *costatus* Lansberge from the same locality, but the description of the latter differs in respect to certain particulars. In any case it is obviously closely allied to *dissidens* Pér., but may be distinguished not only by the male genitalia but by the form of the stridulating rows on the propygidium.

Heteronycus infans Klb.

Mitt. Mus. Hamb., xiv, Beih. 2, 1897, p. 83, fig. 6.

Translation of author's description :—

" Piceous, shining, rufous brown beneath, coxae brighter; clypeus shortly biapicate in front, frons finely rugose, carina slender, interrupted medially; prothorax a third part wider than long, a little attenuate anteriorly, anterior angles rectangular, very little produced; sides curved, posterior angles rounded, dorsum wholly smooth and impunctate; elytra twice as long as the prothorax, punctate striae paired, punctures in striae moderately impressed, third and fourth striae abbreviated before the apex, first interval widened in front and there marked with several punctures, outer intervals between the paired striae irregularly punctate throughout to the apex; anterior tibiae tridentate, teeth almost equal, the middle one slightly the larger, margin above angulate close to the first tooth and resembling a fourth tooth; terminal joint of anterior tarsi thickened, cylindrical, claws unequal, the outer * one geniculate, broad and incurved.

Length 8½ mm.

" Quilimane (February, 1889), one example.

" Somewhat the size of *H. tristis* Bhn. from Natal, but markedly narrower. Clypeus also with two short projections in front, frons more weakly wrinkled, the weak transverse carina between the epistome and the frons interrupted in the middle. Prothorax less contracted in front, anterior angles hardly projecting, sides more strongly rounded. Punctate striae on the elytra weaker; second interval of the elytra much wider than the basal part;

* It is the *inner* claw of the male *Heteronychus* which is dilated.

the middle striae indistinct. Anterior tibiae with three little teeth, without any sign of a little fourth tooth between the first and second teeth, but with a tooth-like projection above the first tooth."

This is the only described member of Group I which lacks an intermediate denticle on the front tibiae.

Heteronychus impudens sp. nov.

(Plate XIX.)

Small species, with a rather long prothorax; black, with pectus; legs and other appendages castaneous; front margin of clypeus truncate, reflexed and bidentate; head weakly rugose, frons distinctly impressed, clypeal carina interrupted medially and raised on either side, frontal carina fine, distinct, obsolescent in median impression; prothorax about one-fourth broader than long, impunctate; lateral margins subparallel basally for about half the length, anterior angles short, posterior angles almost rectangular; marginal stria turning the basal angles and extending for a very short distance along the posterior margin; elytra with lateral margins subparallel; juxta-sutural striae deep, but remainder hardly impressed, consisting of rows of small closely set punctures; the dorsal rows very strongly paired, with intervals 2, 4, 6 and 8 punctate throughout their length: stridulating striae moderately broad, almost parallel, slightly convergent both anteriorly and posteriorly, consisting throughout of fine closely set folds, with no basal coarsening distinguishable; pygidium with a closely punctate basal band occupying rather more than the basal fourth, remainder glabrous; pygidial fold simple; anterior tibiae with one intermediate and one basal denticle.

8·5 mm. × 4 mm.

Single male from Abyssinia (Akaki R., *Ph. C. Zaphiro*).

This species is apparently not unlike *infans* Klb. from Moçambique, but the clypeal carina is certainly not particularly slender, and Kolbe does not mention the impressed frons and elevation of the carina on either side.

Heteronychus densatifrons Fairm.

Ann. Soc. Ent. Belg., xxxi, 1887, p. 20.

Translation of author's description:—

"Length 12 mm. Allied to the preceding" (*obtusifrons* Fairm.),

"but smaller, elytra shorter, ampliated behind, head narrowed in front, very closely rugulose, apex of clypeus blunt, scarcely reflexed and very slightly and bluntly biangulate, clypeal suture wanting; prothorax smooth, posterior angles obtuse; elytra strongly striate, striae more finely punctate, apex rugoso-punctate, pygidium closely and very finely punctato-asperulous in median portion of base; metathorax and abdomen closely and finely rugulose at the sides; anterior tibiae thickened in the middle, shortly and moderately sharply tridentate outwardly, tarsi thickened, last joint swollen, inner claw the larger and broader."

Abyssinia (*Raffray*). Apparently described from a single male.

The meagreness of the above description leaves the writer altogether in doubt as to the affinities of this species.

GROUP II

Heteronychus arator F.

Syst. Entom., i, p. 33.

(Plate XX.)

H. transvaalensis Pér. Trans. S.A. Phil. Soc., xii, 1900, p. 520.

Black; antennae, palpi, pectus, and, for the most part, the legs, ferrugineous or castaneous; abdomen black or castaneous, points of anterior tibiae usually black; clypeus triangulate in front, margin strongly reflexed on either side of median prominence, oblique and slightly incurved; clypeus and front margin of frons transversely rugose, head not impressed; clypeal carina slightly raised and more or less interrupted medially; frontal carina entire, very slender medially where it is slightly arcuate; prothorax with sides subparallel in basal three-fifths, impunctate or extremely finely and obscurely punctate, marginal stria extending just round basal angles; scutellum impunctate, usually with a faint median longitudinal impression; elytra a little ampliate in posterior three-quarters, with the striae fairly strongly to very weakly impressed, paired or unpaired; lateral striae obsolescent except basally; dorsal intervals commonly impunctate, but punctures are frequently present on the fourth and sixth and sometimes on the second; the apical portion of the eighth is almost invariably more or less punc-

tate; stridulating rows straight or very slightly curved, narrow, rather more than their width apart basally, subparallel in basal half, diverging slightly apically; in the basal half the folds are much coarser, but in many males the rows actually narrower, due to the shortness of the folds, than in the finely striate apical portion; in most females the rows are, however, narrower apically; pygidium almost entirely smooth, with a narrow or finely rugulose basal band and finely rugulose angles; pygidium smoothly convex in the male, but in the female often subcarinate with a median impression on the lower half, which also slightly interrupts the curve of the pygidium when viewed from above; pygidial fold fine and simple, sometimes slightly broadened and flattened medially in the male; anterior tibiae with one intermediate and one basal denticle.

9–15 mm. × 5–8 mm.

Found throughout the less arid regions of the Cape Colony and in many parts of the Transvaal and Natal. Also in S. Rhodesia (Salisbury, Gwelo, Mt. Chirinda), N. Rhodesia (Ft. Jameson, *Neave*), Katanga (Kambove, *Neave*), Kenya Colony (Nairobi), Abyssinia (*Raffray*). Kolbe records also from Tanganyika Territory.

Mr. G. J. Arrow kindly compared two dissected males from Cape Colony and Natal respectively with the type in the British Museum and pronounced them identical.

H. arator is a distinctly variable species, the limits of which it is very difficult to define by external characteristics alone. The writer has examined a male from the Cape in which the pygidium showed quite a broad rugulose basal band, and the form of the stridulating bands vary to some extent. All the specimens from Southern Rhodesia and East Africa examined have been considerably smaller than those from the South African Union, and there is a marked tendency in these specimens to pairing of the elytral striae. The impression of these striae varies from very slight to firm. It was originally thought that this subvariety must represent the species described by Fairmaire under the name of *rugifrons*, in which connection the notes under the description of that species may be consulted.

Through the courtesy of Dr. Péringuey the writer has been enabled to examine the type of *transvaalensis* Pér. and must unhesitatingly regard this name as a synonym of *arator*. The male genital armature is slightly stouter than usual, but not more so than some other specimens examined. The median impression of flattening of the

pygidial fold is to be found in many typical specimens of this species.

In connection with *arator* F. several specimens have been examined which leave the writer in doubt as to whether they belong to this species or not. If they are examples of *arator* they are aberrant in respect to certain characteristics, but as it is desired to avoid multiplication of species on the basis of insufficient material it is proposed to describe the peculiarities of each for the information of other students of the family, without raising them for the present to the dignity of specific rank.

1. A single male from Katanga, Belgian Congo (Lufira R., 3,500 ft., *Neave*), in coll. British Museum. Length 13·5 mm. Differs from typical *arator* in that the elytral striae are much more coarsely and deeply punctate, slightly paired; intervals 2, 6 and 8 bear a straggling series of coarse punctures; the male genital armature is similar in form to that of *arator*, but longer and narrower basally. (See Plate XXI, fig. *a*.)

2. One male from Abyssinia (*Raffray*) and another from Zanzibar, both in the collection of the British Museum. Length 11 mm. Practically indistinguishable externally from the East African forms of *arator* F., but male genital armature as at Plate XXI, fig. *b*.

3. One male from Nairobi, Kenya (*T. J. Anderson*), in collection of Entomological Branch, Salisbury. 9 mm. × 5 mm. Broader in proportion to its length than typical *arator*, but otherwise similar. The elytral striae are firmly impressed and strongly paired, the dorsal intervals smooth except the sixth, which bears a number of indistinct punctures, the stridulating bands are broader and the folds are coarser basally than in typical *arator* and the roughened basal band on the pygidium is slightly wider. Male genitalia as at Plate XXI, fig. *c*. It is thought that this will prove to be a distinct species.

4. Two females from Masai Reserve, Kenya (*T. J. Anderson*), in collection of Entomological Branch, Salisbury. 12 and 10 mm. respectively. Differ from the typical *arator*, in that the median impression of the pygidium extends practically from base to apex and is unusually deep; the contour of the pygidium when viewed from above is strongly incurved in the middle, producing a bi-mammilate effect. This is probably merely an aberration of *arator*.

Heteronychus rugifrons Fairm.

Ann. Soc. Entoml. France, Vol. I., Ser. 5, p. 36.

Translation of author's description and notes :—

"Length 10–11 mm. Ovate, convex, black, shining; head, except the vertex, coarsely punctate, transversely carinate, carina interrupted, clypeus impressed on either side, obsoletely bidentulate; prothorax narrowly marginate, hind margin almost straight, scutellum smooth, elytra shortly ovate, deeply punctato-striate, striae paired, intervals slightly convex, apex closely punctate, pectus thinly alutaceous, abdomen very smooth, pygidium strongly convex, very shiny, narrowly and obsoletely asperulous at the base, anterior tibiae tridentate, first tooth distant from second, interval obsoletely crenate, anterior tarsi of male thickened.

"Sainte-Marie-de-Madagascar, Zanzibar (*Ch. Coquerel*).

"Resembles small specimens of *plebejus*, but blacker, more shining, shorter, more convex, the clypeus is more punctate, less wrinkled, impressed on either side, which makes the transverse carina appear more prominent; the elytra are shorter, more punctate at their extremities; the abdominal segments are convex and altogether smooth."

This species has also been identified by Benderitter from Kenya Colony.

The above description appears to apply almost in toto to many Southern Rhodesian and East African specimens of *arator* F. A specimen with firmly impressed elytral striae forwarded to M. Benderitter for comparison with the specimens from Kenya, was, however, kindly compared by M. Pierre Lesne at the Paris Museum, who reported as follows :—

"The example from Rhodesia differs from that from Shimoni in that the branches of the aedeagus are distinctly longer, slightly dilated at the apex instead of being regularly attenuate, the punctation of the elytra is much feebler, consisting of simple points instead of being surrounded by a frame with a double outline."

M. Benderitter's example was identified from the description only, but it would at least appear that there is a species of *Heteronychus* in East Africa answering to Fairmaire's description of *rugifrons* and distinct from the local variety of *arator* F.

Heteronychus pygidialis Klb.

Entoml. Nachrichten, No. 21, 1900, p. 332.

(Plate XVIII.)

♂. Black or castaneous; points of anterior tibiae black, remaining portion of legs, other appendages, pectus and venter castaneous or ferrugineous; clypeus transversely rugose and plicate, anterior margin as in *arator* F.; clypeal carina slender, slightly uneven and somewhat obscure owing to plication of clypeal surface, more or less interrupted medially; frontal carina entire, but also slender and slightly uneven, faintly biarcuate or retrosely angulate medially; prothorax with lateral margins subparallel in basal half, thence attenuate to anterior angles; dorsal surface smooth, very obscurely punctate; marginal striae terminating in basal angles; scutellum with a faint median impression; elytra hardly ampliate posteriorly, striae not paired, moderately to firmly impressed and somewhat finely punctate; dorsal intervals practically impunctate, but a few very fine points may be present on the second and fourth, eighth interval punctate apically; lateral striae for the most part very weak; stridulating bands broader and markedly coarser in respect to the folds basally, where the rows are approximated, narrower, with finer folds and divergent apically; pygidium smoothly convex in male with basal one-fourth to one-third punctato-rugulose; pygidial fold very fine and simple at middle; anterior tibiae with, one intermediate and one basal denticle.

9–10 mm. × 5–6 mm.

♀. The writer has not seen a specimen of this sex, but Kolbe describes the pygidium as obtusely carinate transversely and impressed behind the carina.

Tanganyika Territory; N. Rhodesia (on road Ft. Jameson to Lundazi, 4,000 ft., *S. A. Neave*). Kolbe's types were from Lake Tanganyika and Udjidji to the eastward of that lake.

A close ally of *arator* F., but differs from this species most conspicuously in respect to the divergent stridulating rows, the greater width of the basal rugulose band on the pygidium, and, of course, the shape of the male genital armature.

H. pygidialis is a smaller species, the clypeus and frons are more plicate than in *arator* F., and the elytral striae in general more firmly impressed. The shape of the female pygidium does not apparently differ very markedly from that of some *arator* females.

Heteronychus muticus Bend.

" Voy. de Ch. Alluaud et R. Jeannel en Afrique Orientale," 1911–12, Ins. Col., xii, 1915, p. 389.

Black; pectus and appendages mostly ferrugineous or castaneous; front margin of clypeus of the *arator* type, but very strongly reflexed and prominently bidentate on either side of the median angle; surface of clypeus and anterior portion of frons transversely rugulose; clypeal carina slender, interrupted medially; frontal carina indistinct, coalescing with clypeal on either side and retrosely angulate in the middle; prothorax with sides subparallel in basal half, slightly contracted at the base, anterior angles prominent, marginal stria terminating in basal angles, surface obscurely punctate; scutellum impunctate and not impressed; elytra ampliate in apical two-thirds; striae firmly impressed and somewhat roughly punctate, distinctly paired, fourth stria abbreviated; dorsal intervals impunctate, a few punctures in the apical portion of the eighth interval; stridulating bands broad with coarse folds at the base, but obsolete in the apical third, the bands are well apart and parallel, the coarse folds extend over nearly two thirds of the segment, the bands becoming narrower towards the point where they are obliterated (possibly the apical portion may be persistent in the male); pygidium smoothly convex, the basal half finely punctato-rugulose; pygidial fold fine and simple at middle; anterior tibiae with one intermediate and one basal denticle. Female.

Length 11 mm.; width 6 mm. Benderitter gives Long. 10–12 mm.

Benderitter gives the following localities:—Kenya Colony; Kijabe in the Kikuyu Escarpment, alt. 2,100 metres (*Alluaud et Jeannel*, Feb. 1912); Mombassa (do. do. Oct., 1911); plains below Mt. Kenya, western slope, altitude 1,800–2,000 metres (*Alluaud*, Nov. 1908).

The only specimen of this species seen by the writer is a female kindly presented by M. P. Lesne of the Paris Museum.

This species is very similar to *mosambicus* Pér., but is readily distinguished by the presence of an intermediate denticle on the front tibiae and the much broader punctato-rugulose basal band on the pygidium. Its nearest relatives appear to be *tristis* Bhn. and *pygidialis* Klb.

Heteronychus tristis Bhn.

Insecta Caffraria, 1857, Pars. II, p. 9.

(Plate XIX.)

Black; pectus, venter and appendages ferrugineous or castaneous; clypeus triangulate in front and of the same type as *arator* F., but margin very strongly reflexed and the folds on either side of the median point more prominent; head, except vertex, rough and transversely plicate; clypeal carina distinct laterally; broadly interrupted medially; frontal carina separate, entire and biarcuate; prothorax subparallel in basal half or slightly contracted basally, obscurely punctate; marginal stria terminating in basal angles; scutellum impunctate with a faint longitudinal median impression; elytra ampliate in apical three-quarters, strongly punctato-striate dorsally, the punctures large and deep; lateral striae not impressed but punctate throughout entire length; the dorsal striae are less oblique than in most species and the second interval, therefore, narrower; striae not conspicuously paired; second, fourth and sixth intervals punctate or impunctate, third and fifth impunctate; eighth subseriato-punctate; stridulating bands narrow, in the male narrower basally than apically, but folds coarser basally, where rows are several times their width apart; bands slightly divergent apically and slightly incurved near the margin; basal half of pygidium closely ruguloso-punctate; pygidial fold narrow and simple; anterior tibiae with one intermediate and one basal denticle.

8–9¼ mm. × 4–5 mm.

Natal, Cape Colony (?).

Boheman's type measured 9¾ mm. × 5½ mm. and was taken near the Gariep (Orange) River, presumably in Cape Colony.

Kolbe places this species in the group with *licas* Klug, but the clypeus is conspicuously of the *arator* type, as indeed it is distinctly described by Boheman.

Heteronychus andersoni sp. nov.

(Plate XX.)

Black, shining; pectus, legs and other appendages in part ferrugineous; anterior margin of clypeus similar to *arator* and strongly reflexed; head glabrous, irregularly, broadly and somewhat transversely pitted and plicate, clypeal carina interrupted medially;

frontal carina fine, distinct and arcuate in the centre; prothorax with lateral margins somewhat rounded and narrowed posteriorly, especially in the male; anterior angles acuminate, posterior angles broadly rounded; the marginal stria extends slightly round the posterior angles; prothorax clearly but finely punctate, the punctations being rather stronger and more thickly set laterally and anteriorly; scutellum rather short, impunctate; juxta-sutural striae on elytra very deep; remaining dorsal striae paired, impressed and the punctures thickly set and somewhat confluent; the supralateral striae although scarcely impressed except basally are clearly marked to their apices by their close punctures; intervals more or less impunctate except for an indistinct series on the sixth and eighth; stridulating rows in the male broad at the base and the folds coarse and wide-set over rather more than half the length of the segment; apical portion of rows narrow and consisting of fine, closely set folds; rows approximated basally and slightly divergent in coarse portion, then abruptly divergent to posterior margin, where they are slightly incurved; in the female the fine apical portion is indistinct, but the coarse basal portion is similar to the male though scarcely as wide; pygidium smooth apically with the basal third closely punctate in the male; in the female the band is somewhat narrower and finely rugulose; pygidial fold fine and not impressed; anterior tibiae with an intermediate and one basal denticle.

9–10 mm. × 5–5½ mm.

One male and one female from Naivasha, Kenya, per Mr. T. J. Anderson.

One male from Lake Baringo, Kenya, per M. R. Ford.

The stridulating striae are very characteristic and unusual in a member of this group. The species seems allied to *congoensis* Klb. and *foveolatus* m. It differs from the description of *rugifrons* Fairm., to which species it apparently bears a considerable superficial resemblance, in the absence of any conspicuous impression of the clypeus and in the broad punctate or rugulose basal band on the pygidium. The clear punctation of the prothorax would also hardly have escaped M. Fairmaire's notice.

Externally *andersoni* very closely resembles *muticus* Bend. and the females might easily be mistaken for that species. The only definite external distinctions appears to lie in the median retrorse angulation of the frontal carina in *muticus* and the form of the stridulating bands on the propygidium.

Heteronychus congoensis Klb.

Entoml. Nachrichten, No. 21, 1900, p. 334.

(Plate XXI.)

Short, stout species; black or castaneous; antennae, palpi and venter ferrugineous, legs for the most part castaneous; clypeus triangulate in front as in *arator* F.; head except vertex transversely rugulose; clypeal carina very fine, somewhat indistinct, interrupted medially; frontal carina also very fine, closely approximated to clypeal on either side and curved backward medially; prothorax hardly contracted behind and attenuate gradually to anterior angles, finely and obscurely punctate; marginal stria extending for a short distance on either side along the posterior margin; scutellum impunctate and not impressed; elytra slightly ampliate in posterior two-thirds, deeply striate dorsally, with the punctures large and deep; striae distinctly paired; lateral striae weak; broader intervals more or less punctate, especially the sixth and eighth; apex of elytron closely foveolato-punctate; stridulating bands moderately broad, straight, even in width, the folds slightly coarser basally; bands about twice their width apart at the base and diverging slightly to apical margin; basal half of pygidium finely rugulose; pygidial fold very narrow and simple; anterior tibiae simply tridentate without denticles; (male only examined).

9 mm. × 5 mm.

Belgian Congo (Nyangwe, *R. Mayne*). A single male in British Museum collection.

Kolbe's type is also a single male from the lower Congo. It is described as black, whilst the British Museum specimen is castaneous, and the length is given as 9·5 mm. The specimen examined agrees very closely with Kolbe's description.

Heteronychus puerilis Klb.

Entomol. Nachrichten, No. 21, 1900, p. 335.

Translation of author's description and notes :—

"In size and form similar to *H. congoensis*, slightly smaller and narrower, shining, almost similarly short; frons and epistome a little rugose transversely, smooth at the vertex; prothorax attenuate anteriorly, marginal stria terminating in posterior angles; elytra similar, a little longer than broad, striae however paired; wider

intervals half again or twice as broad as others (narrower), smooth, impunctate, outer ones slightly punctate. Length 8·5 mm.

"Malange in Angola (*Dr. P. Pogge*).

"Amongst the smallest species, nearly related to *H. congoensis*, the body (is) not so broad. The marginal stria of the pronotum reaches only as far as the hinder angles, in *H. congoensis* it extends along the hind margin. The elytral striae are distinctly arranged in pairs; in *H. congoensis* most of the striae are equally distant from one another; the punctations on the broader intervals are either lacking or very weak."

Described apparently from a single male. It is to be presumed that in characteristics not mentioned in the above description, such as the transverse carinae on the head, the punctation or otherwise of the pronotum, the depth of the elytral striae, the shape of the stridulating rows, the form and sculpture of the pygidium and the anterior tibiae, this species resembles *congoensis* Klb., but this is not certain.

Heteronychus foveolatus sp. nov.

(Plate XIX.)

Black or castaneous, glabrous; pectus, legs and other appendages in part ferrugineous; front margin of clypeus of the *arator* type; head except basal portion obliquely plicate or transversely rugose; clypeal carina prominent and somewhat broadly interrupted medially; frontal carina touching clypeal on either side of interruption, somewhat obsolescent medially, but forming there a backward projecting triangle; prothorax attenuate gradually from back to front, usually finely punctate anteriorly and laterally, but in some specimens the surface is practically impunctate; marginal stria continued along entire posterior border of prothorax, although much shallower in dorsal part than laterally; scutellum with faintly impressed longitudinal line and frequently a few scattered indistinct punctures, particularly towards anterior angles; elytra rather short, increasing gradually in width for about two-thirds of their length and then rounded regularly to apex, lateral margins not sinuate; juxta-sutural stria deeply impressed with punctures almost obliterated, remaining dorsal striae also impressed and strongly punctate, lateral striae not impressed but well defined by punctations; striae distinctly paired and broader intervals (2, 4, 6 and 8) with a series of strong punctures extending from base to apex; intervening

intervals impunctate; apex of elytra closely, deeply and broadly foveolate; stridulating rows very narrow, narrower in the female than in the male, and approximately even in width throughout, folds not very greatly coarser basally than apically, rows well apart at base and only slightly divergent posteriorly; pygidium with basal half closely punctate and apex smooth; fold of pygidium narrow and simple at middle; anterior tibiae without an intermediate denticle, but margin angular above basal tooth.

Length 10–12 mm.; width 5½–6½ mm.

S. Rhodesia (Salisbury, Mazoe, Lomagundi): eleven examples.

Guinea (Gaboon), one female (Coll. *du Chaillu*).

A female in the British Museum collection labelled "Guinea, Gaboon," collected by du Chaillu, measures only 9 mm. × 5 mm. and the punctures in the elytral intervals, especially the second interval, are not as coarse as in S. Rhodesian examples. There appears little doubt, however, that it belongs to the same species.

The continuation of the marginal stria along the entire posterior margin of the prothorax has not been noted in connection with other species. This species is apparently allied to *congoensis* Klb.

Heteronychus approximans Klb.

Entomol. Nachrichten, No. 21, 1900, p. 333.

Translation of author's description and notes :—

"This little species clearly belongs to the neighbourhood of the small *H. rugifrons* Fairm. (Madagascar, East Africa), and is also somewhat smaller than this species. The hind angles of the prothorax are more widely rounded, the elytra are punctate in the second interval towards the base as well as in the sixth and eighth. The front legs have no denticles between the second and third teeth. The stridulating rows are almost similar.

"Black, shining, pectus, abdomen and legs in part nigropiceous, antennae, palpi and tarsi reddish-brown, head transversely rugose, subopaque, epistome attenuate, triacuminate at the apex, frontal carina flattened, almost obsolete, prothorax transverse, smooth, impunctate, attenuate anteriorly, somewhat wide behind, anterior angles acute and projecting, posterior widely rounded; elytra longer by half than the prothorax, punctato-striate; intervals almost flat, alternate ones in part slightly narrower, second interval broader and punctulate anteriorly, sixth and eighth with several

punctures, anterior tibiae 4-dentate, fourth tooth (above) obsolete; propygidium with the stridulating rows narrow, divergent posteriorly, pygidium transverse, somewhat highly convex, moderately widely, finely and closer rugoso-punctate at the base. Length 10 mm.

"N. Transvaal (*collected by Fruhstorfer*).

"The frontal carina is very weak. The prothorax is very smooth and not punctate, narrower in front than behind, the front angles somewhat acute and projecting, the engraved marginal stria extends as far as the rounded hinder angles. The posterior edge of the prothorax is very weakly biarcuate and somewhat projecting in the middle. The elytral intervals are partly equal, inclined, however, to arrangement in pairs; the third pair is separated from the middle pair by a distinctly wider interval."

The description of *inops* Pér., which follows, should be consulted in connection with this species.

Heteronychus inops Pér.

Trans. S.A. Phil. Soc., xiii, 1908, p. 653.

(Plate XIX.)

Black to castaneous, pectus (sometimes also venter) and appendages for the most part castaneous; clypeus triangulate anteriorly and similar to *arator* F.; head except vertex transversely rugose, frequently more or less plicate; clypeal carina fine, sometimes rather obscure, more or less interrupted medially; frontal carina distinct, entire, very fine, biarcuate, with a median backward pointing angle; prothorax subparallel in basal two thirds, impunctate or obscurely punctate; marginal stria terminating in basal angles; scutellum impunctate with a faint median longitudinal impression; elytra slightly ampliate in apical two-thirds, striae little to moderately deeply impressed and clearly punctate, not or only slightly paired, fourth and fifth frequently abbreviated; lateral striae very weak except basally; dorsal intervals usually impunctate, but punctures may be present on second and sixth; stridulating bands broader with much coarser folds in basal half, very narrow and fine in apical half; about their own width apart basally, parallel for half their length and then divergent, or nearly straight and divergent, usually more so in female than male; pygidium smooth with a finely punctato-rugulose basal band covering from less than one-fourth to one-third of the total area in the male, usually

much narrower and more finely rugulose in the female, but may cover one-fifth of the length of the segment in the middle and considerably more in the lateral angles; pygidial fold very fine and simple; anterior tibiae without an intermediate denticle, but with the margin just above the basal tooth slightly angulate in the male, much more sharply angulate and prominent in the female.

8–10½ mm. × 4¼–5¾ mm.

S. Rhodesia (Marandellas, Umvuma, Lalapanzi, Somabula, Shangani); Angola; N. Transvaal (?).

Differs from *arator* in respect to clypeal carina, which is more slender, stridulating bands, which are broader basally, narrower apically and more divergent, basal band on pygidium, which is much wider and more rugulose in male, and lack of an intermediate denticle on anterior tibiae. Male genitalia very distinct.

Dr. Walther Horn very kindly compared specimens of *inops* from S. Rhodesia with the type, a single female, of *approximans* Klb. in the Berlin Museum and expressed the opinion that the two species are distinct. The distinction rests upon the clear punctation in *approximans* of the elytral intervals and the broader rugulose basal band on the pygidium in the female. The writer has, however, examined a female from the N. Transvaal (the same locality as Kolbe's specimen), which agrees with Kolbe's description in respect to the punctation of the elytral intervals, but the pygidium is similar to that of most S. Rhodesia *inops* females, *i. e.* it is smooth except for a narrow very finely rugulose basal band and not as in Kolbe's description "moderately widely, finely and closely rugose-punctate at the base." This specimen is to all appearance *inops* with punctate dorsal intervals. A single male from Angola, which from the genital armature is undoubtedly *inops*, has a clear series of punctures on the second interval and a number on the sixth.

It is clear, therefore, that *inops* Pér. and *approximans* Klb. cannot be separated on the basis of punctation or otherwise of the elytral intervals, and we are left with only the different width of the basal band on the pygidium as a point of difference. Kolbe is not very explicit on this point, but Dr. Horn informed the writer that the pygidium in *approximans* is "broader sculptured" than in the specimens of *inops* forwarded. As Kolbe's type is a single female and the width of this band is a somewhat variable

feature in many species too much weight cannot be given to the distinction. In S. Rhodesian females of *inops* the width of the band may be as much as one-fifth of the length of the segment, although usually considerably less. In view of this variation it appears not unlikely that the two names may relate to the same species, in which case *approximans* Klb. would have precedence.

Heteronychus beiranus Pér.

Trans. S.A. Phil. Soc., xiii, 1908, p. 653.

(Plate XX.)

Black; appendages and underparts, including venter, fuscous or castaneous; front margin of clypeus similar to *arator* F., and strongly reflexed; surface of clypeus and anterior portion of frons transversely rugulose, vertex of head smooth; clypeal carina prominent, interrupted medially, more widely and completely in the female than in the male; frontal carina coalescing with clypeal on either side, entire but very slender medially, where it is slightly curved backward; prothorax with sides subparallel in basal half, surface smooth, very obscurely punctate; marginal stria terminating in rounded basal angles; scutellum impunctate and not impressed; elytra with sides slightly sinuate about one-third their length from the base but very little ampliate posteriorly; dorsal striae slightly paired, for the most part firmly impressed and somewhat finely punctate, lateral striae weaker but clearly marked by punctures; second, fourth, sixth, and eighth intervals all with a straggling series of punctures, which are however confined to the posterior half of the fourth; stridulating bands narrow, slightly broader basally where the folds are coarser, approximated at base, divergent posteriorly and very slightly excurved in the middle; pygidium smooth with a punctulate basal band broader and more rugulose in the male, in which it occupies somewhat less than one fourth of the segment; pygidial fold simple; anterior tibiae without an intermediate but with a clear basal angulation in both sexes.

Length 8 mm.; width 4–4·25 mm.

One male and one female from Moçambique (Beira).

The specimens described above are the two types of the species kindly lent by Dr. Péringuey.

The likeness between this species and *mosambicus* is very close indeed; the present species is, of course, much

smaller and the male genital armature is very distinctly different, but in the event of female examples approximating in size positive identification would be a difficult undertaking.

Heteronychus mosambicus Pér.

Trans. S.A. Phil. Soc., xiii, 1908, p. 652.

(Plate XXI.)

Black, shining; appendages and underparts for the most part castaneous; anterior margin of clypeus of the *arator* type, very strongly reflexed; dorsal surface of clypeus and anterior portion of frons transversely rugulose; vertex of head smooth; clypeal carina prominent, interrupted medially, more widely and completely in the female than in the male; frontal carina coalescing with clypeal on either side and forming a slight backward projecting angle in the centre (this is clearer in the male than in the female); sides of prothorax subparallel in basal three-fifths, thence curving roundly to anterior angles; surface smooth, obscurely punctate at the sides; marginal stria terminating in basal angles; scutellum impunctate with a faint longitudinal median impression; elytra with sides slightly sinuate about one-third of their length from the base, but very little ampliate posteriorly, glabrous; dorsal striae firmly impressed and clearly punctate, scarcely paired; lateral striae weaker, but clearly marked by their punctures throughout; sixth and eighth intervals in both sexes with a number of small punctures, in the female the second interval is also punctate; stridulating bands narrow with the folds little coarser basally, uniform in width, straight, several times their width apart at the base and slightly divergent posteriorly; pygidium smooth with a narrow very finely rugulose basal band in the male and finely ruguloso-punctate basal angles, in the female only the lateral angles are ruguloso-punctate, the remainder of the surface being practically smooth; the pygidial fold in the male is slightly broader than in the female, and is slightly ampliated with an inward projection medially; anterior tibiae without an intermediate denticle, but with a strong basal angular projection in the female (the tibiae of the male example are rather worn).

Length 10–11 mm.; width 5–5½ mm.

One male and one female from Moçambique (Beira).

The specimens described above are the two types of the species kindly lent by Dr. Péringuey.

This species is clearly related to *congoensis* Klb. and *foveolatus* m. The stridulating bands are very like those of the latter species.

Heteronychus simulans sp. nov.

(Plate XXI.)

Castaneous, underparts and appendages in part ferrugineous; front margin of clypeus as in *arator* F.; head transversely rugose; clypeal carina prominent and broadly interrupted; frontal carina slender, coalescing with clypeal on either side of interruption and lost in rugosity of head medially; prothorax attenuate gradually from back to front, very finely and obscurely punctate laterally (punctations hardly discernible under a lens × 16); anterior angles little prominent; posterior angles obtuse, marginal stria just passing the basal angles; scutellum impunctate and not impressed; elytra hardly ampliate posteriorly; dorsal striae (2–6) roughly equidistant from each other, little impressed and punctures rather shallow; lateral striae very weak except basally; intervals mostly impunctate, but a few indistinct points on sixth and eighth; stridulating rows moderately broad, even in width, straight, with the folds coarser basally, separated by rather more than own width at base and slightly divergent to apical margin; pygidium smooth with a narrow aciculate basal band; pygidial fold narrow and simple at middle; anterior tibiae with one basal denticle only.

10½ mm. × 5½ mm.

A single male, S.E. Katanga, Belgian Congo, 4,000 ft. (*Neave*).

Very similar to *arator* F., but male genitalia widely different, and anterior tibiae without an intermediate denticle.

Heteronychus parumpunctatus Burm.

Handb. Ent., v, 1847, p. 95.

(Plate XXI.)

Black or castaneous; underside and appendages for the most part ferrugineous or castaneous, but anterior tibiae commonly black; clypeus with a prominent median point on front margin, margin sharply reflexed and slightly incurved on either side; head slightly impressed medially; clypeus and fore part of frons densely

and transversely rugulose; clypeal carina indistinct in front of the eyes, widely interrupted medially and elevated into a short rounded ridge on either side of the interruption; frontal carina extremely fine, coalescing with clypeal on either side and crossing the median interruption as a fine slender transverse thread; prothorax short, attenuate gradually from back to front; strongly but not very closely punctate anteriorly and less closely elsewhere (the degree of punctation, however, varies considerably); marginal stria terminating in basal angles or extending for a variable distance along the basal margin, scutellum impunctate with a median longitudinal impression; elytra with lateral margins sharply sinuate about one-fourth of their length from the base and ampliate thence in apical three-quarters; striae little impressed, shallowly punctate and strongly paired; broader dorsal intervals more or less punctate, the sixth and eighth broadly punctate throughout their length, though the punctures are sometimes weaker on the eighth; stridulating bands moderately narrow in the males, about even in width, straight or slightly incurved apically, with the folds much coarser in the basal half; bands about their own width apart at base and slightly divergent to apical margin; the rows are slightly narrower and finer as to the folds in the female, and are usually incurved close to the apical margin of the segment; pygidium in the male with a finely rugulose or aciculate basal band which may be quite narrow or occupy as much as one-third of the segment; the lateral angles are in any case rugulose; in the female the pygidium is almost entirely smooth, though for the most part finely, sparsely and somewhat obscurely punctate, with a narrow aciculate basal band and the angles more or less rugulose; pygidial fold narrow and simple; anterior tibiae without an intermediate, but with one basal denticle.

12½–16½ mm. × 6½–8½ mm.

Nubia (Sennaar, Blue Nile), three males, two females; S. Rhodesia (Salisbury), three males, two females.

In Burmeister's type, which is a male from Nubia, the pygidium is described as "glaberrimo," whereas in the above-mentioned three males from that region there is a moderately broad rugulose basal band. In the S. Rhodesian specimens, on the other hand, the pygidium is smooth. Again, the marginal stria on the prothorax in the Rhodesian specimens extends round the basal angles and for a short distance on either side along the basal margin whereas in the Nubian specimens it terminates in the angles. The male genital armature is, however, identical in specimens from both localities as

also are the dimensions, the females averaging considerably larger than the males.

Although this species appears closely allied to *fossor* Reiche, and to *puncticollis* m., the form of the anterior margin of the clypeus is different, that of the present species being similar in this respect to *arator* (see figures of clypeus in *arator* and *fossor*).

Heteronychus puncticollis sp. nov.

(Plate XXI.)

Piceous black or castaneous; pectus, legs and other appendages in part ferrugineous; front margin of clypeus with a more or less distinct median angle, but margin on either side very weakly reflexed and not incurved, rendering the apical angle very obtuse; head except basal portion, which is smooth, closely reticulo-punctate, with a distinct median impression; clypeal carina broadly interrupted and raised on either side of the median impression; frontal carina coalescing with clypeal and almost obsolete medially, although frequently to be traced as a very slender arcuate line; prothorax attenuate gradually from back to front, but may be slightly constricted behind, sparsely punctate with the punctures coarser and more closely set along the anterior margin and particularly in the anterior angles; the marginal stria just passes the basal angles and is there obliterated; scutellum impunctate, with a faint longitudinal impression in either sex, which is, however, frequently obsolete; elytra about as wide as long, slightly broadening from the base for about one-third of their length and thence distinctly ampliate; juxta-sutural striae very deep with the punctures very indistinct; remaining striae paired, moderately impressed or rather shallow, the punctures being somewhat small and shallow; the lateral striae, strongly impressed and coarsely punctate for a short distance basally, are obsolescent or obsolete elsewhere; dorsal intervals impunctate, but a straggling series of punctures usually present on sixth and eighth; stridulating bands straight, narrow apically, but wider and coarser as to the folds basally, wider in the male than in the female, approximated at base and moderately divergent posteriorly; pygidium smooth except for a narrow finely punctate basal band, rather broader and more coarsely punctate in the lateral angles; a shallow impression on either side towards the basal angles is frequent in the females; fold of pygidium narrow

and simple medially; anterior tibiae with no intermediate denticle and basal denticle distinct or obsolescent.

Males 9–12 mm. long × 5–7 mm. broad.
Females 11–14·5 mm. long × 6·25–8 mm. broad.

S. Rhodesia (Salisbury), seven males and eight females.

This species is very similar to *parumpunctatus* Burm., but is distinguished by the front margin of the clypeus, which in the latter species is much more strongly reflexed and incurved on either side of the median point. The margin of the clypeus in *parumpunctatus*, in fact, resembles that of *arator* F. whereas in *puncticollis* it resembles that of *fossor.* The male genitalia, of course, are quite distinct.

There appears to be a possibility of the new species being the same as *memnonius* Klb. from Angola, which was described from a solitary female. The latter specimen is, however, considerably larger (17 mm.) and the prothorax is described as very obscurely punctate in the anterior portion only whereas in the larger specimens of *puncticollis* the punctations are quite distinct. Too much weight must not, however, be attached to this variable characteristic.

Heteronychus memnonius Klb.

Entomol. Nachrichten, No. 21, 1900, p. 331.

Translation of author's description and notes :—

"This West African species is manifestly somewhat closely allied to *H. amplus*, from Madagascar; it is rather more slender, but for the rest similar in size and form. The two shortened frontal carinae are, however, more distinct, higher and better defined. The prothorax is not so short, the anterior angles are markedly shorter and the whole of the dorsal surface is punctate.* The elytra are less deeply punctato-striate, and the striae less clearly paired. The pygidium is smoother and above all only wrinkled towards the basal angles.

"Ovate, piceous black, shining, underside castaneous; head rugose, dull, frons impressed in the middle and furnished with two transverse tubercles; epistome subarcuate in front (obliterated? worn?), scarcely acuminate in the middle; prothorax smooth and impunctate, sparsely and finely punctulate in front, sides roundly attentuate anteriorly, anterior angles short, on either side pos-

* The last statement refers to *amplus*, not to the present species, and constitutes an obvious inversion.

teriorly are four little foveolate impressions, hind margin slightly subsinuate; elytra smooth and finely punctato-striate, six dorsal striae scarcely impressed, lateral striae (seventh and eighth) obsolete, intervals scarcely or indistinctly paired, sparsely punctate, anterior tibiae tridentate, upper tooth smaller than the others; stridulating rows on the propygidium somewhat divergent behind, moderately narrow and finely striate; pygidium smooth, very sparsely punctulate, almost shining, with a single impressed point on either side near the base, which is very finely and shortly rugose-punctulate with the medium dorsal portion smoother. Length 17 mm.

" Malange in Angola (*Dr. P. Pogge*).

" The frons is dull black and weakly wrinkled transversely, also somewhat punctate. The frontal carina is broadly interrupted in the middle. The front margin of the epistome is rounded, but feebly angulated forwards in the middle, perhaps shortened through use. The prothorax is roundly contracted towards the front, the dorsal surface entirely smooth, only weakly punctate towards the anterior angles. These are rectangular and little projecting. The engraved marginal stria extends only as far as the obtuse rounded posterior angles. The elytra are only weakly striate and " (the striae are) " of little depth, disappearing posteriorly and on the sides; the punctures on the striae are weak. The stridulating rows on the propygidium diverge posteriorly more than in *H. amplus* and are finely striate."

Described apparently from a single female.

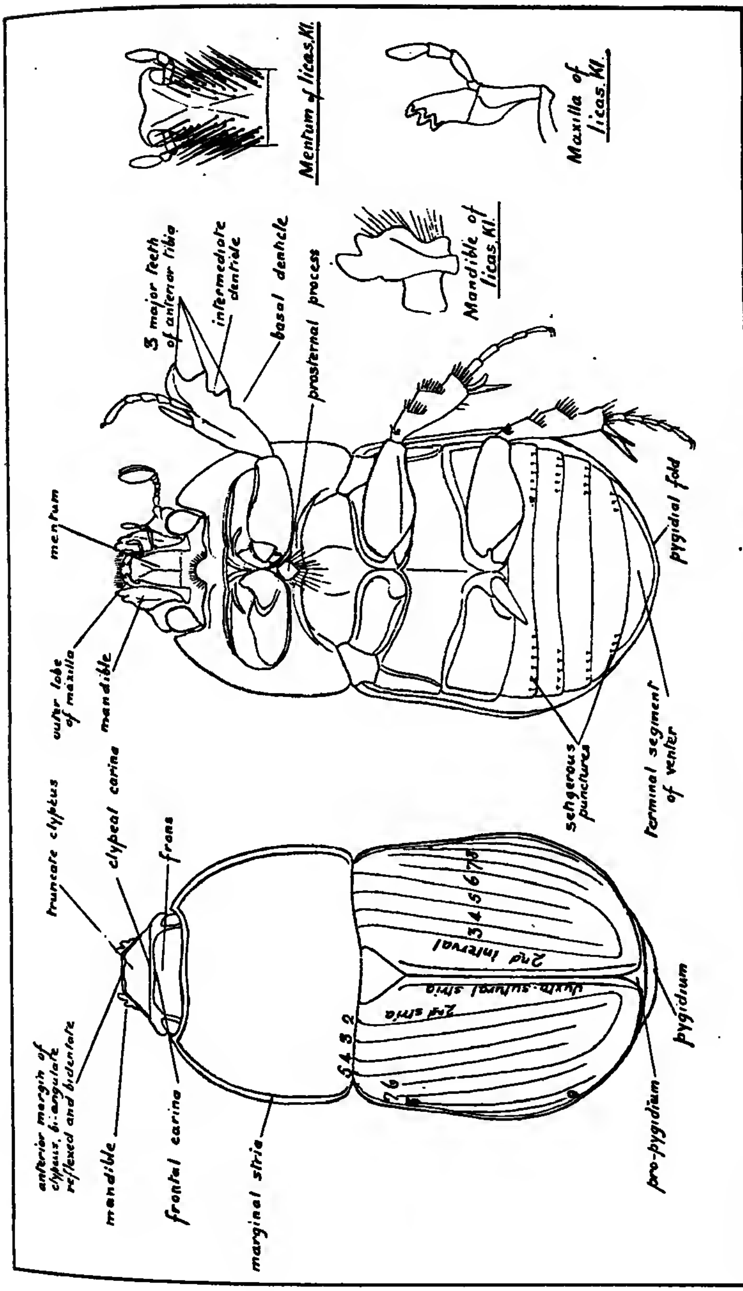
Except in the larger size given the description is very similar to that of the new species *puncticollis* from S. Rhodesia, but admitting that the epistome is worn down it might almost equally well apply to *parumpunctatus* Burm. which also occurs in S. Rhodesia. The females of the latter species attain to at least 16½ mm. in length. Kolbe, however, appears to have been familiar with *parumpunctatus*.

Heteronychus fossor Reiche.

Ferret et Galinier, " Voyage en Abyssinie," iii, 1847.

(Plate XVIII.)

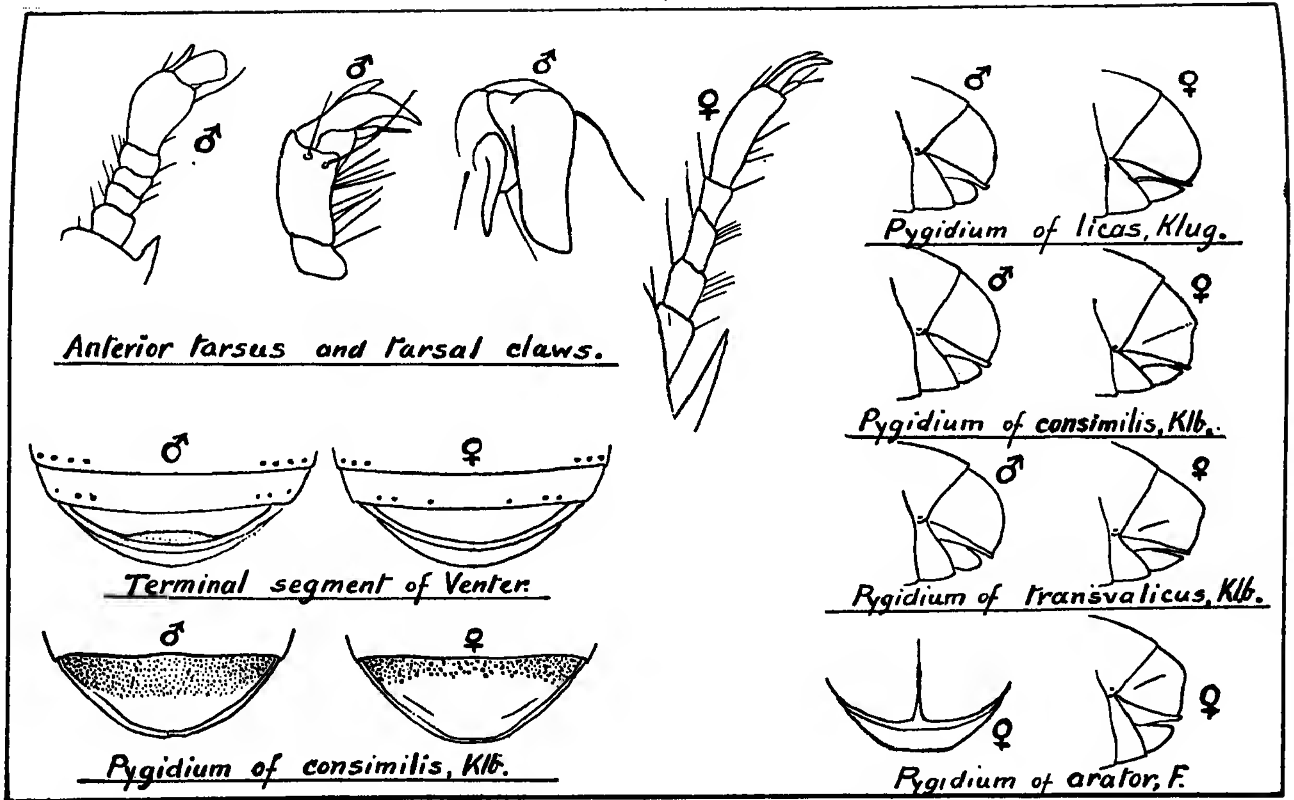
? *H. modestus* Thomson. Arch. Ent., ii, 1858, p. 68.
? *H. rudestriatus* Fairm. Ann. Soc. Ent. Belg., 1893, p. 20.



R. W. J. del.

HETERONYCHUS, STRUCTURAL DETAILS.

Vaus & Crampton.



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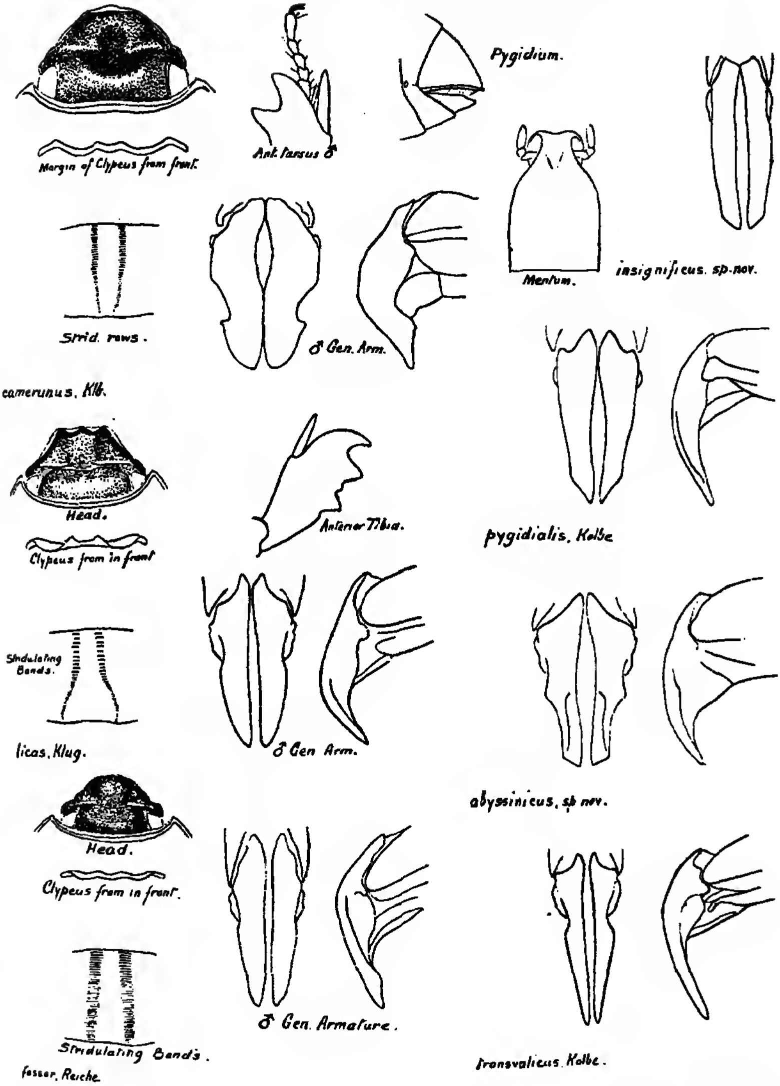
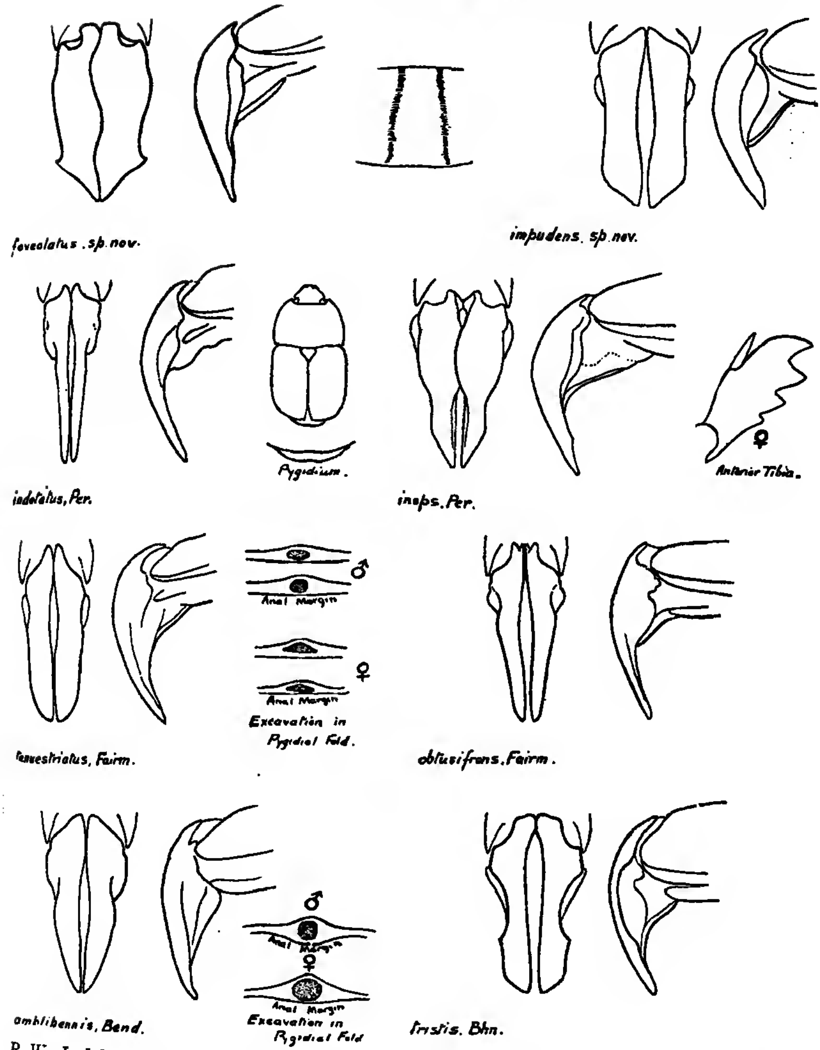
Vaus & Crampton.

SEXUAL DIVERGENCE IN HETERONYCHUS.



R. W. J. del. Vaus & Crampton.

MALE ARMATURES OF HETERONYCHUS.



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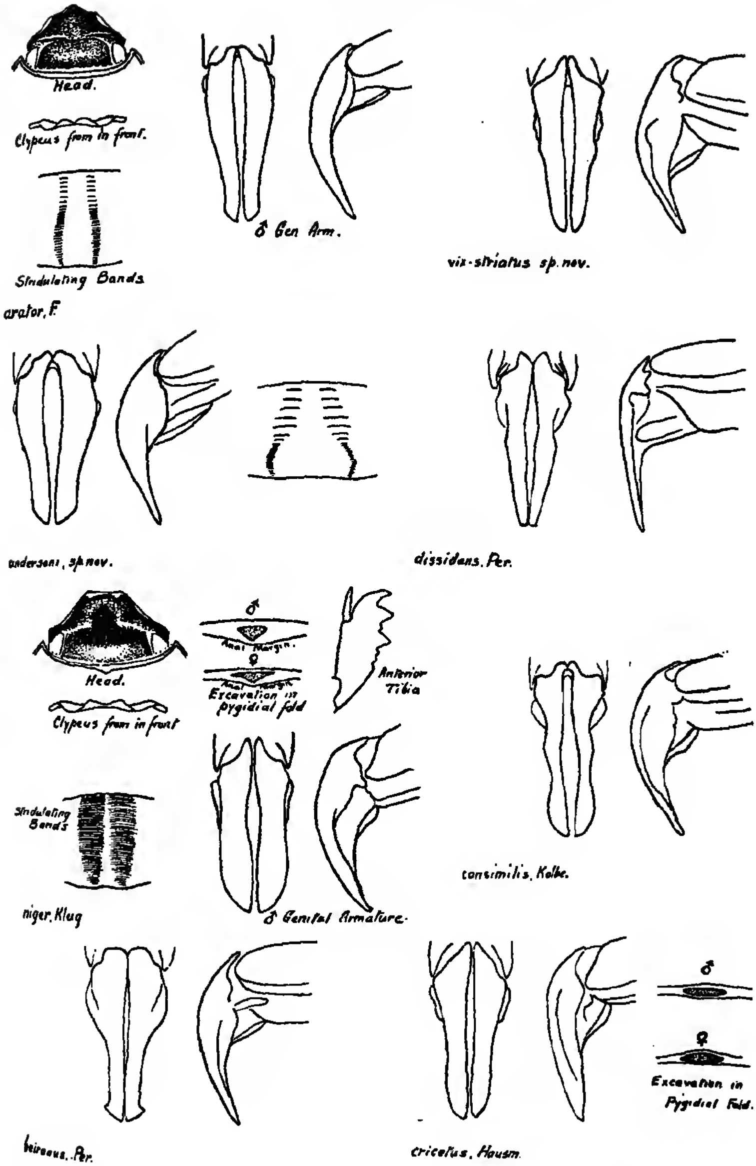
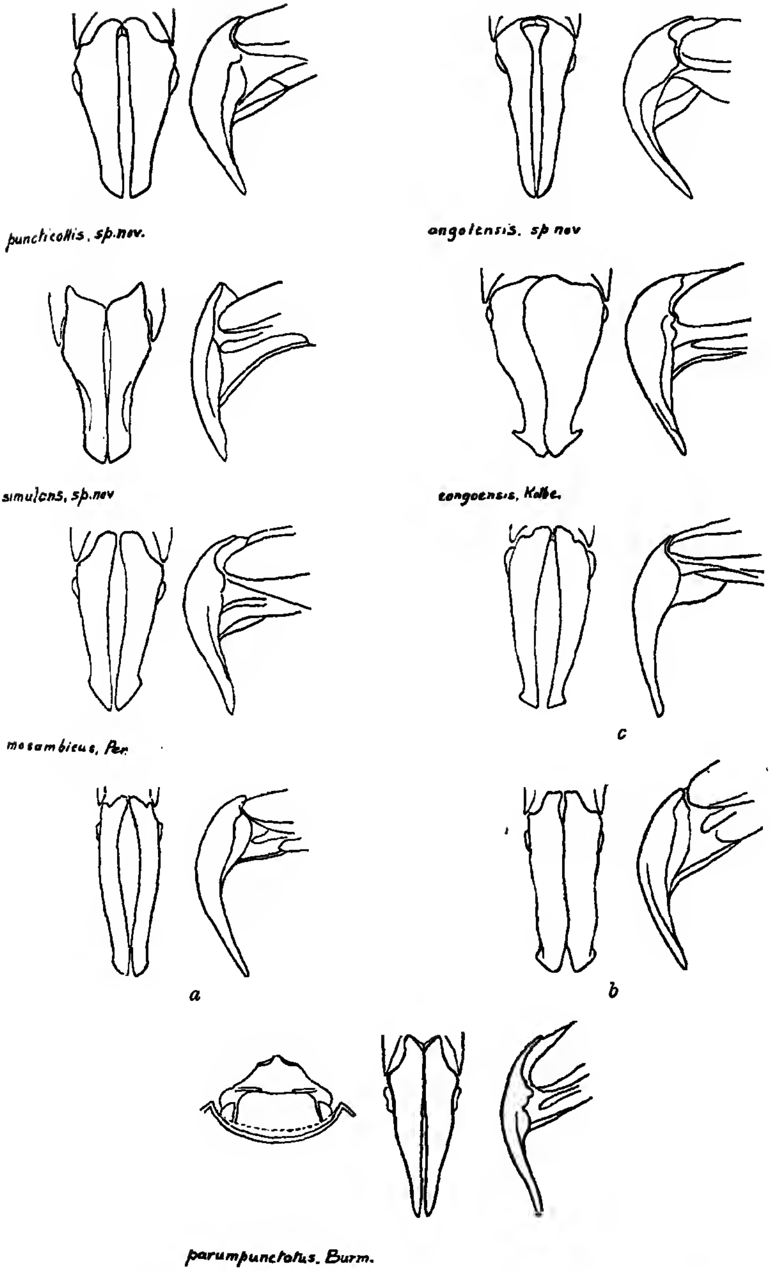
Vaus & Crampton.

MALE ARMATURES OF HETERONYCHUS.



R. W. J. del. — Vaus & Crampton.

MALE ARMATURES OF HETERONYCHUS.



R. W. J. del. — *Vaus & Crampton.*

MALE ARMATURES OF HETERONYCHUS.

? *H. ascanius* Klb. Entom. Nachrichten, xxvi, No. 21, 1900, p. 330.

Colour almost entirely fuscous or castancous; clypeus with a median point in front, margin only lightly reflexed and not dentate; head very lightly impressed medially; clypeus and anterior portion of frons closely rugulose, vertex of head smooth; clypeal carina elevated, widely and completely interrupted; frontal carina coalescing with clypeal on either side, extremely fine, transverse or shallowly arcuate medially; prothorax rather short, attenuate gradually from back to front, sparsely and sometimes obscurely punctate, the punctures coarser and more distinct anteriorly (in the three authentic specimens before me one, a female, shows the punctures much coarser than the other two, a male and female); marginal stria extending well round basal angles; scutellum impunctate, with or without a longitudinal impression; elytra ampliate in apical three-quarters; dorsal striae moderately impressed, coarsely punctate and distinctly paired; lateral striae obsolescent except basally; broader intervals more or less punctate, the second and fourth being practically impunctate in one specimen, sixth subseriopunctate throughout its length; punctures on eighth interval fine and indistinct; stridulating bands rather broad in male, straight, even in width, with folds very slightly coarser basally; about the width of the rows apart basally and slightly divergent to apical margin; in the female the rows are considerably narrower; pygidium almost entirely smooth, but sparsely punctate close to basal margin and more closely in lateral angles; in the female there is an impression on either side towards the angles, a faint suggestion of a similar impression is present in the male; pygidial fold fine and simple; anterior tibiae without any intermediate, but with one basal denticle.

10–12 mm. × $5\frac{1}{2}$–$6\frac{1}{2}$ mm.

Abyssinia (*Raffray*), Senegal. Reiche's type is from Abyssinia and is in the British Museum. Mr. G. J. Arrow kindly compared a female from Senegal with the type before forwarding the British Museum material.

Kolbe's description of *ascanius*, based on a single female from Senegal, differs only in the fact that the elytral striae are stated not to be paired (a variable characteristic in several other species). He suggests that *ascanius* Klb. is probably a subspecies of *parumpunctatus* Burm., which *fossor* closely resembles, and as he confesses elsewhere his entire lack of acquaintance with Reiche's species, which certainly occurs in Senegal, the synonymy of the two names is highly probable.

H. rudestriatus Fairm. is from Abyssinia and is stated by Fairmaire to resemble both *parumpunctatus* and *fossor*. It appears probable that Fairmaire also was unacquainted with *fossor*, from which species he distinguished *rudestriatus* by apparently translating Reiche's description of the frontal carina (*sens. lat.*) "le front ne presente qu'une fine carène ondulée," whereas *rudestriatus* is described as bearing two approximated tubercles on the frons, a description which more or less fits the specimens of *fossor* I have examined. The colour of *rudestriatis*, is, however, given as piceous-black, whereas the British Museum series of *fossor* comprises no specimens deeper than castaneous in colour.

H. modestus Thomson is from Gaboon. It is stated by Thomson to be extremely near to *ascanius* Dej. (= *ascanius* Klb.), and the points of difference given appear to be very trivial: "the head more strongly rugose, the prothorax with the anterior angles more pointed, the scutellum sharper, the elytra shorter with the intervals more finely punctate and the tibiae strongly tridentate." The inclusion of the latter characteristic is curious as Kolbe gives *ascanius* tridentate tibiae which are of course also a characteristic of *fossor*. Thomson describes *modestus* as blackish-brown so that the colour is evidently similar to or only slightly darker than *ascanius*. On the whole there appears little justification for regarding Thomson's species as distinct.

Heteronychus insignificus sp. nov.

(Plate XVIII.)

Small species of the size and form of *tristis* Bhn.: castaneous, pectus, legs and other appendages for the most part ferrugineous; front margin of clypeus obtusely triangulate as in *fossor* Reiche, lightly reflexed, and weakly biarcuate from the front; frons and clypeus transversely rugose, not impressed; clypeal carina obsolete and frontal carina very slender, hardly discernible, entire and shallowly arcuate medially; prothorax gradually attenuate from back and front, sparsely and shallowly punctate; marginal stria terminating in posterior angles; scutellum with a longitudinal median impression, impunctate; elytra slightly ampliate in posterior three-quarters, striae deep, coarsely punctate and strongly paired; lateral striae weak and hardly impressed except basally; intervals two, six and eight punctate; stridulating rows moderately broad,

coarser basally where they are approximated; they diverge fairly strongly for not quite half their length and are thence subparallel to the apical margin; pygidium almost entirely smooth with a few punctures along the basal margin; pygidial fold slightly arcuate inwardly medially but not impressed; anterior tibiae simply tridentate.

8·5 mm. × 4·5 mm.

A single male, Abyssinia (*Raffray*).

This species differs from Kolbe's inadequately described *puerilis* from Angola, which is of the same size, in that the second, sixth and eighth intervals on the elytra are distinctly punctate, and, presuming the pygidium of the latter two species to resemble that of *congoensis* Klb., in that this segment is almost entirely smooth instead of rugulose in the basal half. The two specimens are, of course, from widely different localities.

Explanation of Plates XVI–XXI.

PLATE XVI.

Heteronychus.
Structural details.

PLATE XVII.

Heteronychus.
Sexual divergence.

PLATE XVIII.

Male Armatures.

Fig. 1. *Heteronychus camerunus.*
2. „ *licas.*
3. „ *fossor.*
4. „ *insignificus.*
5. „ *pygidialis.*
6. „ *abyssinicus.*
7. „ *transvalicus.*

PLATE XIX.

Male Armatures.

FIG. 1. *Heteronychus foveolatus.*
2. „ *indotatus.*
3. „ *tenuistriatus.*
4. „ *amplipennis.*
5. „ *impudens.*
6. „ *inops.*
7. „ *obtusifrons.*
8. „ *tristis.*

PLATE XX.

Male Armatures.

FIG. 1. *Heteronychus arator.*
2. „ *andersoni.*
3. „ *niger.*
4. „ *beiranus.*
5. „ *vix-striatus.*
6. „ *dissidens.*
7. „ *consimilis.*
8. „ *cricetus.*

PLATE XXI.

Male Armatures.

FIG. 1. *Heteronychus puncticollis.*
2. „ *simulans.*
3. „ *mosambicus.*
4. „ *angolensis.*
5. „ *congoensis.*
6. „ *parumpunctatus.*
a. *arator,* f. 1.
b. „ f. 2.
c. „ f. 3.

XX. *On the Early Stages of* Chrysiridia ripheus *Dru.* By H. Eltringham, M.A., D.Sc., F.Z.S.

[Read October 17th, 1923.]

Plate XXII.

With the material kindly sent me by the Bishop of Madagascar, and referred to in my paper on the tympanic organs of this insect, there were included several larvae in various stages, a pupa in its cocoon, and a few fragments of the plant on which the larva feeds.

The early stages of this, probably the most beautiful moth in the world, have been described, in some cases quite wrongly, but no figures of the larva and pupa have, so far as I am aware, been published. Previous references and some account of the errors made in former descriptions will be found in Saalmüller's work, Lepid. v. Madag. Abhandl. Senckenberg. Naturforsch. Ges. xvii, 1892.

In the report of the International Congress of Zoology, August 1892, Pt. 1, p. 180, there also appears a short but interesting paper on the species, by M. R. P. Camboué. He states that its great beauty has attracted the attention of the natives, who call it "Lolonandriana," which means the King Butterfly. M. Camboué found the larva on a species of *Omphalea*, of which the native name is "Huzomalay." After a short description of the larva the author states that in the warm region of the Madagascar littoral the duration of the pupal stage is about a fortnight, and the moth hatches out in the middle of the night. In the higher regions from Imérina to the centre of the island the insect is found in various stages from January to May, whilst in the lower and warmer parts it is found nearly all the year round. The moth is on the wing from eight in the morning till five or six at night, and flies rather high. It remains quiescent all night.

M. Chauvin of Tamative, who obtained the specimens for me at the request of the Bishop of Madagascar, states in a letter that though occurring all the year round, the moth is most plentiful from May to July, and frequents

flowering trees. The larva is fully grown in about a month, and in summer the pupal stage lasts two to four weeks, and in winter as much as three months. In the sun the moth is fully expanded in an hour, but takes two or three hours when in the shade.

On Plate XXII I have drawn various stages of the insect from the examples sent to me. The figure of the egg, much magnified, was drawn from a specimen removed from the body of a female, and is therefore probably not fully matured. It is yellow and slightly flattened. There are eighteen longitudinal ribs, the intervening spaces being marked by exceedingly fine latitudinal striations. The smallest larva received is 22 mm. long, and the largest 53 mm., the latter probably nearly fully grown.

There seems to be no very marked difference in colour or pattern between the young and the old larva. The head is yellowish-brown, spotted with black, the first segment black, spotted with yellowish-brown, the second black, and the third nearly all black, but posteriorly on the dorsal region, yellowish-white. The fourth to the ninth segments are creamy white spotted with black in a manner too irregular for detailed description, but roughly conforming to the following pattern. A double row of dorsal spots, generally small and broken up, but coalescing into large and conspicuous spots on segments 7 and 8. Laterally there follows a fairly continuous row of small spots, about four on each segment, and beneath this a second row, smaller and less regular. Spiracles black and larger lateral spots on segments 7 and 8, followed by lateral-ventral lines, more or less coalescent. Prolegs tinged with deep yellow. Tenth segment shows more black than cream-colour, while the eleventh and twelfth are black laterally and ventrally. Anal area deep yellow with black spots. The larva has many long black spatulate processes. These fall off so easily that it is rather difficult to decide their true number and position. Comparison of several examples seems to show that the first segment has none, the second and third eight, the fourth to the eleventh six, and the twelfth four.

The young larva has a number of short bristles, especially along the lateral ventral area, but in the older examples these seem to be confined to the head, second segment, and legs.

The pupa is umber brown, dark on head and wing cases,

lighter dorsally and on abdomen. The dorsal and abdominal regions are striped and spotted with black-brown, as shown in the figure, and the last segment bears four bristles.

The cocoon is very large in comparison with the size of the pupa, and is formed of a beautiful and fairly regular network of brown silk, the texture of which recalls the appearance of a section of vegetable cellular structure. It would seem to afford little protection in view of its open mesh, though it is probably partly rolled up in leaves. A few particles of the larval excreta are entangled in the fabric.

The plant on which the larva feeds has kindly been identified by Dr. A. B. Rendle as *Omphalea biglandulosa* Muell. Arg. (Euphorbiaceae). The fragments sent were completely decolorised by the preservative, so that the colour shown in my plate may not be correct.

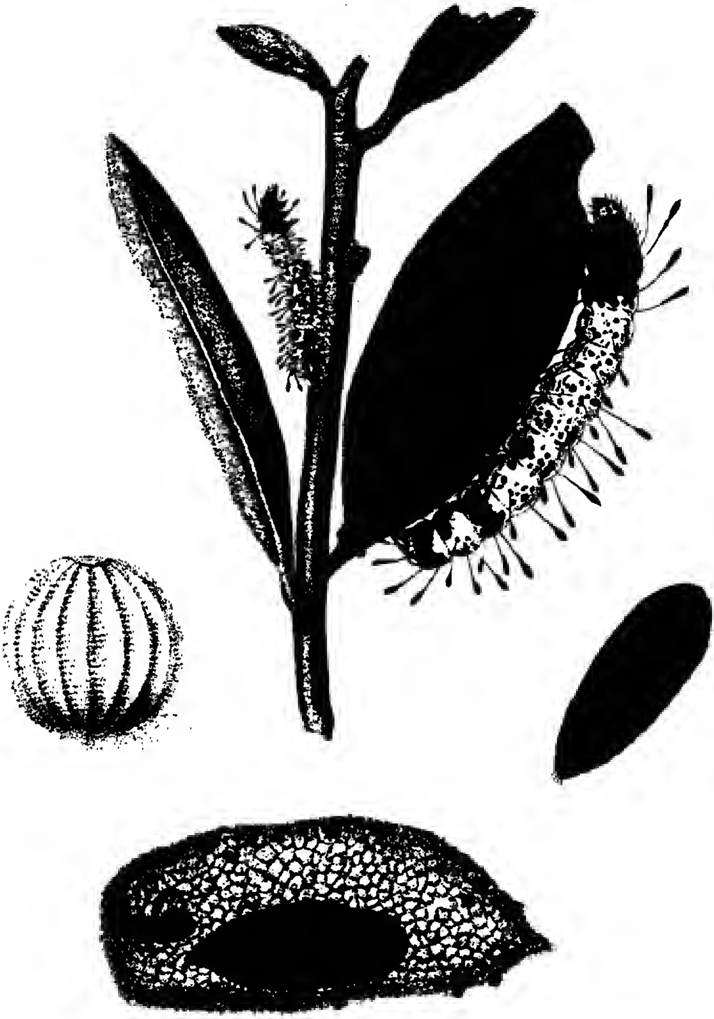
It is interesting to compare this larva and pupa with that of *Cydimon leilus* from Trinidad, as described by L. Guppy, jun., in our Transactions for 1907, p. 405. The larva of this beautiful Uranid feeds on *Omphalea megacarpa* Hemsley. The egg appears to be very similar to that of *ripheus*, and is described as spherical, yellowish, and having about twenty longitudinal ribs. The larva when hatched is white with black transverse lines and downy hairs. After the first moult the spatulate processes appear, two on the second, four on the third, and two on the tenth segments. The head becomes reddish spotted with black. After the second moult two more spatulate processes appear (on the eleventh segment) and after the third moult two more (on the twelfth). Guppy states that after the third and fourth moults the larvae vary considerably in colour from yellowish to red-brown, while the spatulate processes increase in number. The pupa is described as yellowish-brown with black dots and lines, and the cocoon as a network of yellowish-red silk fastened between two leaves of the food-plant.

The general similarity of the early stages of the S. American and Madagascar species, the association with the same genus of plants together with the resemblance of coloration in the imagines, would seem to indicate great antiquity and stability of characters, coupled with a very wide distribution of the ancestral form. I am indebted to my friends Mr. Tams of the British Museum and Com-

mander Walker of Oxford for useful references to *ripheus* and allied species.

Explanation of Plate XXII.

Egg, two specimens of the larva, and the pupa and cocoon of *Chrysiridia ripheus*. The egg is much magnified, the remaining figures are natural size.



H. Eltringham del. Huth lith.

EARLY STAGES OF CHRYSIRIDIA RIPHEUS.

XXI. *On the Tympanic Organ in* Chrysiridia ripheus *Dru.* By H. Eltringham, M.A., D.Sc., F.Z.S.

[Read October 17th, 1923.]

Plates XXIII–XXV.

In the Cambridge Natural History, Insecta, Pt. II, 1889, the late Dr. Sharp called attention, on p. 419, to a curious structure which he had observed in the abdomen of species of Uraniidae.* His remarks are as follows :—

" In all the species of the family we have examined, we have noticed the existence of a highly peculiar structure that seems hitherto to have escaped observation. On each side of the second abdominal segment there is an ear-like opening (usually much concealed by overlapping scales) giving entrance to a chamber in the body; this chamber extends to the middle line, being separated from its fellow by only a thin partition. At its anterior and lateral part is a second vesicle-like chamber, formed by a delicate membrane that extends as far forward as the base of the abdomen. There can be little doubt that this is some organ of sense, though it is much larger than is usual with Insect sense organs."

Ever since reading the above account I have hoped one day to have an opportunity of investigating the structure in *ripheus*. During a casual examination of specimens of Geometrid Moths I discovered a similar cavity in the abdomen, and, on dissection, observed the complicated tympanic organ, now well known to exist in this and other families of the Heterocera.

I had little hope that my discovery was original, and a search through records, in which I was then, and have since been, much assisted by my friend Dr. K. Jordan, soon proved that I had not underestimated the activities of my fellow-naturalists.

It is perhaps unnecessary here to describe all the known

* Comm. Walker has kindly called my attention to the fact that Dr. Sharp's first mention of the organ was at a meeting of the Cambridge Natural History Society on April 30, 1897, when he stated that he had observed it "some years ago."

references to tympanic organs. Swinton (Ent. Mo. Mag. 14, p. 121, 1877) appears to have described, not very clearly, some of the external features. The same author referred to the subject at subsequent dates (1880 and 1882), and it is mentioned by Minot (Amr. Journ. of Otol. 4, p. 89, 1882). In 1909 (Zool. Jahrb. 27, Anat. p. 631) Deegener published a paper on a new sense organ in the abdomen of the Noctuidae, but seems not to have made a very complete examination of the structure, and has since been shown to be incorrect in his account of the histology. Dr. K. Jordan in 1905 (Novit. Zool. 12, p. 506) made certain observations on the external structure in relation to the sexes. In 1911 F. Eggers (Sitzb. Natf. Ges. Dorpat, 30, p. 138) published a preliminary account of the organ in Noctuidae, which was followed in 1912 by a similar short account of the corresponding feature in Geometridae by Prof. v. Kennel (Zool. Anz. 39, p. 163). Friedrich Eggers then proceeded to investigate more fully the morphology and histology of the tympanal organs in the Noctuidae and other families of the Heterocera. This work was completed in 1913, but owing to certain delays it was not submitted for publication till 1914, when the War intervened and it was not until 1919 that the very elaborate and fully illustrated paper appeared, entitled "Das thoracale bitympanale Organ einer Gruppe der Lepidoptera Heterocera" (Zool. Jahrb. Jena, Anat. xli, pp. 273–376). In it the author gives a list of some 155 species examined. The organ in varying degrees of complexity is thoracic in some groups and abdominal in others. It may be useful here to give a list from Eggers' work of those families in which the structure has been observed.

In the thorax :—

Notodontidae.	Hypaenidae.	Syntomidae (part).
Thaumatopaeidae.	Agaristidae.	Arctiidae.
Lymantridae.	Nolidae.	Hypsidae.
Noctuidae.	Cocytidae.	Lithosiidae.

In the abdomen :—

Drepanidae.	Geometridae.	Epiplemidae.
Cymatophoridae.	Uraniidae.	Pyralidae.
Brephidae.		

If some common Geometer such as *Xanthorrhoë mon-*

tanata be placed in weak spirit, and examined from the side, under the stereoscopic microscope, an opening will be observed at the anterior end of the abdomen, close to its junction with the thorax. This is the external orifice of the tympanal organ. If now the thorax be carefully removed, and the forward portion of the abdomen cut off at about the third or fourth segment, and this anterior part examined from the front, after removal of connective tissue, fat cells, etc., a paired structure will be seen, the most striking features of which are the two delicate tympana, which in certain angles reflect the light like small mirrors. Each has a rather elliptical shape with one side of the ellipse cut off straight. This straight side is the external edge, and forms the anterior margin of the external orifice. The rounded part of what may be called the framework of the drum is heavily bordered with chitin, whilst the straight distal edge appears to be more in the nature of a ligament. The rounded edges of the two drums nearly meet in the centre, and from these inner edges there arise a pair of chitinous bridges, one extending over each drum, from the central or inner curved side to the outer straight ligamentous margin. At its origin on the inner edge the bridge is continuous with the chitinous framework of the drum, but where it joins the outer edge, it appears to be connected thereto by short muscles, or perhaps fibrous bands. The bridge is broader at its centre and ends than elsewhere. From its centre there drops to the drum a delicate nerve, the chordotonal thread.

From this description it will be gathered that the opposite or posterior surface of the tympanum to that on which the nerve is attached, forms the anterior wall of the cavity whose external orifice can be seen in a lateral view of the moth's body. The remaining interior surface of this cavity in the abdomen is formed by a bulbous invagination of the cuticle, sufficiently chitinised to preserve its shape, which is somewhat like that of the body of a kettle drum.

The side of the tympanum on which the nerve enters and over which the bridge lies is in the interior of the body, but apparently forms part of a tracheal vesicle, the chitin bridge serving to prevent pressure of internal organs on the drum.

The two drums are not quite in the same plane, their inner margins being rather posterior to their outward

edges. So far as the nervous distribution is concerned there would appear to be a pair of nerve threads arising from the ventral cord and passing upwards and backwards to give off several branches, one of which passes to the chitin bridge, and running in the delicate connective tissue along its edge, ends in the chordotonal thread already referred to.

In those species which have the tympanal organ in the thorax, a more complicated structure exists. The organs are in the posterior part of the metathorax, and each consists essentially of a modified tracheal vesicle carrying *two* drums or tympana. One of these is the true tympanum with its chordotonal thread, and the other would seem to be a kind of resonator, which Eggers designates as the "*Gegentrommelfell*," a word which I think might conveniently be translated "*contratympanum*."

To those interested I would recommend a perusal of Eggers' work on the subject, since any attempt at a full description of this double-drummed organ would occupy more space than is at my disposal. Having given some account of known forms of these remarkable organs, we may now turn to the Uraniidae, as a type of which I propose to describe the structure and histology of the tympanal organ in *Chrysiridia ripheus*.

The Rt. Rev. the Bishop of Madagascar, who has in the past been a generous contributor to the Hope collections, kindly undertook, during a visit to this country, to obtain for me specimens of this moth, preserved in a manner suitable for histological investigation. For many reasons the consignment was delayed, and late last autumn I mentioned my requirements to Mr. W. F. H. Rosenberg, who promised to obtain, if possible, the desired material. I have to thank him for the great trouble he took in the matter, and for his ultimate success in obtaining the specimens, and I have also to thank the Bishop of Madagascar, since, through the medium of M. Herschell Chauvin of Tamative, his long-promised specimens arrived almost simultaneously with those from Mr. Rosenberg. What at first appeared to be an unnecessarily large amount of material ultimately proved to be a fortunate acquisition. Good histological preparations are difficult and uncertain of attainment with preserved specimens, and since, as will be described, the organs differ much in the two sexes, and the proportion of females secured was small, I could

hardly have obtained satisfactory results from either of the consignments alone.

Methods and Technique.

My instructions to the collectors were to place the insects alive, or very fresh, in alcohol of about 90% mixed with half its bulk of a cold saturated aqueous solution of mercury bichloride. I am not sure whether this method was actually employed. The specimens arrived during my absence from Oxford, and since they might not have been fixed in the desired manner, they were given a bath of alcoholic mercury solution and afterwards placed in clean spirit.

In any case the histological results were on the whole good, though probably inferior to what might have been obtained by using a variety of fixatives applied to fresh material, followed by appropriate methods of staining. I should here make it clear that the preparation of such small and delicate objects as the tympanic nerves or chordotonal threads is a matter of some difficulty, and ample material is a necessity, for possible causes of failure are numerous and occur at all stages of the processes employed. The nerves themselves are ensheathed in a thin envelope of tracheal epithelium, unfortunately heavily nucleated, so that the staining is apt to obscure the nerve elements within. This envelope cannot be mechanically removed with much success, manipulation with the finest needles being somewhat like trying to handle with a crow bar the membrane beneath an egg shell. To see the nerve clearly longitudinal sections are necessary, and these must be extremely thin (2 to 3 μ) if they are to strike the nerve thread more than about twice. Correct orientation of so delicate an object in relation to the microtome knife is naturally difficult, and good results can hardly be expected from a few attempts. Added to this there is the difficulty that in order to see the object at all in the paraffin some of the surrounding tissue must be included, and this tissue is rather heavily chitinised, thus diminishing the chance of obtaining good sections. Nevertheless, with care and a sufficient number of preparations good results are not impossible of achievement. For the benefit of those who are interested in these matters I might mention a method of orientating a delicate object which I have

found effective. Let us suppose it is required to cut a longitudinal section of a thin fibre or nerve. It should first be stained with some easily washed-out dye such as eosin, so as to make it visible under the stereoscopic microscope. Having brought it to the right condition for embedding, the watch-glass of melted paraffin containing the object is brought under the stereoscopic binocular, using a black tile for a stage. The paraffin will first begin to solidify at the bottom of the watch-glass, and the object should be lifted slightly with needles so as to allow a moderate thickness of solid wax to form beneath it. By this time the wax will have begun to solidify round the edges, and a very thin steel straight-edge, such as a six-inch steel rule, is laid across the watch-glass so that its edge is exactly in line with the long axis of the object. With a needle a slight mark is made on the solid edge of the wax at each side, just where the straight-edge crosses the glass. The wax is then rapidly cooled by floating the glass on water and finally plunging it beneath the surface. The wax being completely solidified, a fine line is drawn with a needle across its surface, using the straight-edge and the side marks already made. This line lies over, and gives the exact position of, the embedded object, and the block can then be mounted on the microtome so that the line is parallel with the knife blade, or, if transverse sections are required, at right angles to it.

Though the device is of my own invention I do not claim any special originality for it, and other workers doubtless use it or some similar method; but I have often been asked by students for a means of correctly orientating an object in wax, and I can recommend this as simple, and much more accurate in its results than might be expected. For staining the nerve preparations here to be described I found the iron haematoxylin method the most satisfactory. Nerves were dissected out and lifted from the watch-glass by means of a fine pipette, transferred to slides rubbed over with glycerine and albumen, and placed on a 40° C. electric hot-plate to dry. At this stage it is well to draw with the writing diamond, under a low power, a small circle round the object, as an aid in finding it again quickly. Put the whole slide in absolute alcohol for ten minutes, gradually hydrate and transfer to 2% iron-alum solution for half an hour, wash, and stain in 5% haematoxylin for at least an hour, wash, and differ-

entiate in 1% iron-alum. Eggers obtained good results with safranin-*O*, differentiating in alcohol, but this method was not, in my hands, so successful. Apathy's gold method and other formulae were tried, but with poor results. Some few preparations refused to take even the haematoxylin stain, but in the majority of cases it proved very effective.

The Position and Structure of the Organ in the Male.

Plate XXIII, fig. 1, is a sketch of a lateral view of part of the male abdomen, after partial removal of the scales. The first segment is indicated by the two small plates under 1. It will be noted that the second segment bears a thick pad of scales. These are large, densely packed and very numerous. The third segment shows a deep depression apparently leading forwards into a cavity beneath the scale pad. This is all that can be seen in such a view. If we now carefully remove the scales by scraping with a needle at their attachments, we shall obtain the preparation shown in fig. 2. The posterior margin of the second segment is seen to be thickened and its outline deeply indented in a forward direction. We also see a bladder-like structure, *V*, lying in the cavity formed by the depression of the third segment. It is for the most part a soft and rather delicate opaque membrane, but becomes transparent and still more delicate at *T*, which is the actual tympanum.

If we now cut out the whole side of the body over this area, clear away the fat, connective tissue, etc., with which its inner surface is lined, and turn it over so as to inspect the inner side, we see what I have endeavoured to represent in fig. 3. What was the right side in fig. 2 is now the left. The depression in the third segment is seen to form a more or less hemispherical chamber, *C*, through the wall of which can dimly be seen at *V*, the outline of the bladder-like structure, or tympanal vesicle, and the tympanum itself which looks paler owing to its transparency. On cutting away the invagination of the cuticle of the third segment as along the dotted line in fig. 3, the under or inner side of the tympanal vesicle is shown as in fig. 4, the tympanum again appearing owing to its greater transparency, though it is still on the other or outer side. The thin wall of the tympanal vesicle is much

tougher than the tympanum itself, and in cutting it away great care must be exercised to avoid rupture. If the operation be successfully performed the preparation will now have the appearance of fig. 5, which was drawn under a much higher power. At *M* is a somewhat concave band of radiating muscle fibres. Their purpose is somewhat obscure, though, as they are attached to the membrane of the tympanal vesicle, they would seem to be capable of adjusting the tension of that structure. At *Vc* is the cut edge of the vesicle, *Ct* a mass of tracheal epithelium which at *G* forms a swelling containing a minute ganglion. From this ganglion there passes an extremely fine connection to *N*, which latter is the tympanal nerve or chordotonal thread and is pointed like a tiny arrow-head. Both the fine connection and the chordotonal thread are provided with a delicate sheath of tracheal epithelium. The chordotonal thread is joined to the tympanum *T* at its pointed end. The nerve fibres connecting the tympanic nerve to the ganglion are so delicate that so far I have been unable to remove them with the connection intact. The only practicable method is to mount them separately. Even the eyepiece micrometer becomes a clumsy instrument with which to measure this delicate connection, which, exclusive of the sheath and supporting cells, appears to have a diameter at its thinnest part of about ·0005 mm.

Let us now turn to Plate XXV, fig. 4, which represents a very highly magnified view of the ganglion and the tympanic nerve. The figure is drawn from a longitudinal section of the ganglion combined with a whole preparation of the tympanic nerve. The ganglion is at the lower part of the figure. *Sh* is the sheath of tracheal epithelium, which in its proximal part shows numerous excrescences, each containing a nucleus *Sn*. As it passes to the distal end of the nerve it becomes thinner and the nuclei flatter. I have not shown this membrane as spread over the nerve, since its nuclei would confuse the figure. The structure of the ganglion is not easy to analyse. Cell-walls are hardly at all visible in my preparations, and apparently Eggers found the same difficulty in studying the tympanal nerves of other moths. Judging by the two granulated nuclei *Ln*, there are two large lateral cells. In the centre is a bipolar cell *Sc*, which, having become detached in the section, can be more easily distinguished, and its rather faint nucleus *Scn* can also be seen. For reasons which

will presently appear I am inclined to think that there are at least two of these central cells, and that my section has touched only one of them. Proximally it is drawn out into a bundle of fibres doubtless continuous with the main nerve connection, while distally it diminishes to a delicate strand or axis fibre (already referred to) forming the core of the connection between the ganglion and the tympanic nerve. The remaining structure of the ganglion is peculiar and rather difficult to observe. In the drawing several broad curved dark lines are shown, *L*. These appear to be the indications of a kind of laminated structure. If a hyacinth bulb be cut in two similar lines are seen indicating the cut edges of the scaly leaves, and if one of these ganglia be mounted under compression the appearance is very like that of a crushed bulb. If, however, such a crushed preparation be stained with haematoxylin the effect is not that of scaly leaves, but still appears as black lines, from which I can only conclude that the ganglion contains concentrically arranged rods of a chromatophilous nature. Where the ganglion tapers off to the connecting thread two small nuclei are seen, and these I take to represent sheath or supporting cells.

We now reach the chordotonal thread in which the most conspicuous structures are the two little ribbed fusiform bodies *SS*, shown in the drawing. These or similar structures have been observed in all chordotonal organs, and have been named "scolopales" by Graber. They are hollow bodies, said to contain fluid, and in transverse section show an internally ribbed structure. Eight such ribs were found by Eggers in the forms he examined. Through the centre of the organ a delicate nerve filament passes. In the chordotonal threads of moths the number of these scolopales seems always to be two, and as Eggers has observed, one is always somewhat larger than the other. In the drawing (fig. 4) it will be noted that the proximal end of the scolopale is produced into a peg-like form. This terminal process is very transparent and not easy to see in all preparations. The opposite end seems solid and always stains deeply. It is produced into a filament of extreme delicacy, which also takes the stain, and can in most preparations be traced for some distance in the substance of the chordotonal thread. It should here be noted particularly that the dark solid end of the scolopale is distal, and it is so shown in all Eggers' draw-

ings. We shall return to this point in describing the chordotonal thread of the female.

The remainder of the tympanic nerve shows a faintly fibrous structure, containing several pale nuclei, followed distally by elongated, proximally rounded, and darkly staining bodies, which end distally in two bundles of very delicate fibres also taking a deep stain. The sheath of tracheal epithelium is here extremely attenuated and permits a clearer view of the nerve structures.

Eggers points out that in other chordotonal organs as also in those of moths which he has investigated, the essential structures seem to be a bipolar sensory cell, proximally connected with the central nervous system and distally tapering into the scolopale, the latter being distally attached to a third body called a "cap cell." The other nuclei frequently observed must be regarded as belonging to sheath cells, supporting cells, and other accessory bodies. For this reason we must suppose that the bipolar cell whose nucleus is marked *Scn* in fig. 4 is, as I have already hinted, one of two which connect respectively with the two scolopales. The cap cells are not clearly evident, unless we so regard the elongated stained bodies shown in the distal portion of the figure.

The Position and Structure of the Organ in the Female.

It now remains to describe the corresponding organ in the female, and here we shall see marked differences from that of the male. Plate XXIV, fig. 1, is a sketch of a lateral view of part of the abdomen at its junction with the thorax, after partly removing the scales. The most conspicuous feature is a large flap-like evagination of the metathorax, projecting posteriorly over the first and part of the second abdominal segments.

The posterior edge bears a fringe of scales and hairs, though these are not so dense as in the scale pad which covers the tympanic organ of the male. If this structure be cut away we see beneath it a vesicular body, fig. 2, *Tv*, apparently for the most part buried in the second segment. Its surface is smooth, comparatively hard, and chitinous, while anteriorly it possesses a semicircular thickened margin which forms the framework of the tympanum *T*. In the male the tympanum is so placed as to be nearly parallel with the general lateral plane of

the insect's body. In the female it faces more forward so as to be nearly in a transverse plane. Fig. 3 shows a more magnified view of the tympanal vesicle removed from the body, with part of the cuticle *C* of the second segment, and as viewed from the anterior position. The tympanum is now more distinctly seen and the tympanic nerve *N* can with favourable lighting be observed on its under surface.

If the preparation be now turned over, the rest of the tympanal vesicle can be seen projecting into the body cavity. Unlike the soft and membranous vesicle of the male it is hard and chitinous and of a globe-like formation. Cut away the greater part of it and we have the view illustrated in fig. 4, still more highly magnified, where *Tv* is the remains of the vesicle, *C* the cuticle, now seen from the inner side, *T* the tympanum, and *N* the tympanic nerve or chordotonal thread. In this case the tympanal nerve, while arising from a position similar to that in the male, is without any accessory ganglion. Moreover, whereas the tympanum of the male is a delicate membrane showing little structure, that in the female exhibits in the area immediately surrounding the attachment of the nerve, a dotted and opaque appearance, due to the presence of numerous heavily nucleated cells which project on the external side, *i.e.* the opposite side to that on which the nerve is attached.

At fig. 5 I have shown the appearance of a small piece of the tympanum viewed from the inner side, and at fig. 6 a section of the same, showing the nucleated external prominences, which as will be noted have small setae arising from their surfaces. The finer structure of the female chordotonal thread is shown at Plate XXV, fig. 1. It has a sheath of tracheal epithelium which, from its proximal end to the first enlargement, is ringed with irregular ridges, which in this figure are only shown in section, but partly in a surface view at *Sh*, figs. 2 and 3. Except for its crinkled and irregular form one might compare it with an armoured hose-pipe. It contains many irregular darkly staining nuclei, which unfortunately much obscure a critical examination of the nervous structures within. As far as the first enlargement of the chordotonal thread the nerve appears to be of the ordinary fibrous structure. It then becomes swollen and shows distinctly the two scolopales *S*, and certain large nuclei *Ln*, of which

three are visible in this preparation. The more distal of the scolopales is seen to taper off into a very delicate axis fibre which, expanding into the second enlargement, finally tapers off again to its point of attachment upon the tympanum. In this distal portion both large and small nuclei are seen, and a generally fibrous structure. In describing the male chordotonal thread it was pointed out that the most extensively dark-stained ends of the scolopales were distal. Now in the preparation shown in fig. 1 the reverse is the case, although both ends take the stain to some extent. And here it must be stated that the general shape of the tympanic nerve in the female is very irregular and variable. It can scarcely even be said that fig. 1 shows the commonest form, at least so far as my preparations indicate. Other examples show the first swelling of the organ, not symmetrically placed, but in the form of a lateral expansion of the thread, as in figs. 2 and 3, which are from two other preparations, each peculiar in form. In these two examples the second enlargement is broken away, but its relative position is towards the top of the figure. In fig. 3 the sheath obscures the underlying tissues so completely that only the scolopales can be seen. Nevertheless, all three preparations and also others not figured show the darker-staining portion of the scolopales proximal instead of distal as in the male, and moreover the smaller of the two scolopales is also proximal and not distal as in the other sex. In other words, the scolopales appear to be reversed in position in the female. What the significance of this may be I am unable to suggest. Before asserting that it is the normal condition I should prefer to have many more preparations than my present material affords. An idea which almost inevitably suggests itself is that the tympanal organ may be sound-receptive in one sex and sound-productive in the other, but we do not at present know that one sex of *ripheus* makes a noise of any kind, nor, so far as I am aware, are typical chordotonal nerve structures associated with sound-producing organs. So far as sound-production is concerned we should expect to find some muscular mechanism in connection with the tympanum, and this we certainly do find in the male (see Plate XXIII, fig. 5), but the male scolopales have the normal orientation, and the homologous organs in other moths are generally similar in both sexes, and it has not been suggested that these are

other than sound-receptive. Much further observation of the living animal is necessary before we can profitably discuss the problem.

At Plate XXV, fig. 5, I have shown semidigrammatically the general nerve connections of the tympanal organs in the female. At *Tg* are the coalesced thoracic ganglia from which the central nerve cord *Cn* passes backwards to the abdominal region. Several branches are given off, not all of which are indicated, but at *Ba* is a delicate ramus which is the only connection I can find leading to the margin of the connective tissue bordering on the tympanum, and I take it to be the branch leading to the tympanic nerve. In spite of the apparent difference of structure in the two sexes, the vesicles are of essentially similar formation as I have illustrated in text-figures 1 and 2. Fig. 1 is a diagrammatic section of the female organ. *I* is the integument of the second abdominal segment which is seen to bend sharply backwards and so surround the vesicle *V*, the cuticle *C* of which lines the cavity so formed. This cuticle is itself lined with delicate tracheal epithelium, which, extending across at *T*, forms the tympanum. *P* is the evagination of the metathorax which forms a cover for the tympanum. At text-figure 2 a similar section of the male organ is shown. The invagination of the abdominal integument *I* is shallower, forming a

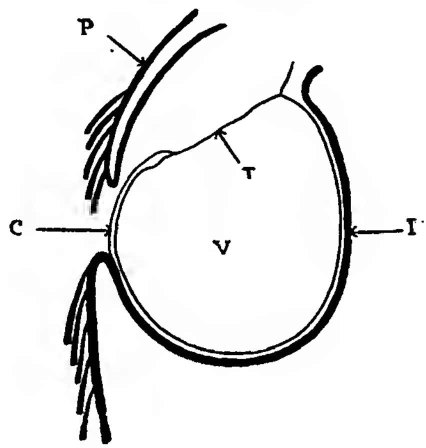


Fig. 1.

mere depression. *V* is the vesicle with its cuticle *C*, thinner and less globular in form than in the female, but forming the small tympanum at *T*. *F* is a mass of fat and muscle cells adjacent to the anterior wall of the vesicle, and *Cs* is part of the pad of covering scales.

As in so many anatomical investigations, so in this, we may arrive at more or less satisfactory conclusions as to the structure and histology of an organ, but the manner and extent of its functions remain in a great measure in doubt. Eggers devotes some space to the function of

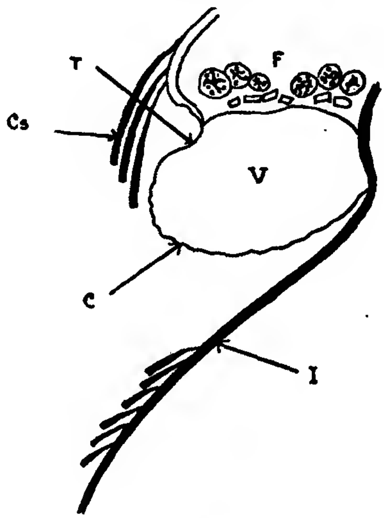


Fig. 2.

these organs, but comes to no very certain conclusions in regard to them. That some insects can hear has been shown by Regen's experiments on *Liogryllus campestris* (Zool. Anz. 40, p. 304, 1912) in which the females were only uninfluenced by the chirping of the males, when their auditory organs had been removed. Several experiments on the hearing powers of moths have been described, but apparently none have been carried out so as to eliminate all sources of error. We know that some moths and butterflies do make noises (*Ageronia*, *Aegocera*, *Halias prasinana*, etc.), but the power so far as at present known is rare, whilst the presence of tympanal organs is of common occurrence. Chordotonal organs have been detected in the

wings, antennae, legs, and bodies of various insects, notably by Vogel in the wings of Lepidoptera (Zeit. Wiss. Zool. 100, p. 210, 1912), and Eggers recalls the presence of swollen nervures in the wings of many species, such dilations being possibly connected with the chordotonal organs found in the wings. Probably in the present imperfect state of our knowledge of insect senses, we can do little more than record the fact that these peculiar nerve structures, or scolopales, are prominent features of organs which in Orthoptera we know to be auditory, and that their presence in moths in conjunction with tympana and tracheal vesicles strongly supports the view that such moths can hear. As to the sounds which they are adapted to detect, we must remember that just as our eyes are sensitive to only a limited range of the spectrum, our ears can respond to sounds of only a certain range of vibrations. The sounds that a moth can hear may sometimes be beyond our range. Insect senses are liable to be highly specialised, and though probably similar to our own in kind, may be adapted to receive physical impressions to which our own senses are not always able to respond.

Explanation of Plates XXIII–XXV.

PLATE XXIII.

Fig. 1. Lateral view of anterior part of abdomen and part of metathorax of ♂ *Chrysiridia ripheus.* 1, 2, 3, segments of the abdomen.

Fig. 2. The second and third abdominal segments after removal of the scale pad. *V*, the tympanal vesicle; *T*, the tympanum.

Fig. 3. View of the inner side of the depression in segment 3. *C*, the abdominal integument; *V*, the tympanal vesicle seen through the chitinous integument.

Fig. 4. Same as fig. 3, but with the abdominal integument cut away to show the vesicle *V*.

Fig. 5. Same as fig. 4, but more highly magnified, and part of the tympanal vesicle cut away. *Vc*, the cut edge of the vesicle; *M*, band of muscle fibres; *Ch*, chitinous ridge; *T*, tympanum; *N*, chordotonal thread; *G*, the ganglion; *Ct*, mass of connective tissue and tracheal epithelium.

Note.—The magnifications vary, but some idea of the actual sizes may be gathered from the length of the chordotonal thread *N*, fig. 5, which is ·1 mm.

PLATE XXIV.

Fig. 1. Lateral view of anterior part of abdomen and part of metathorax of ♀ *Chrysiridia ripheus.* 1, 2, 3, abdominal segments; *Thp*, the evagination of the metathorax covering the tympanum.

Fig. 2. The same with the metathoracic evagination removed. 1, 2, abdominal segments; *Tv*, the tympanic vesicle; *T*, the tympanum.

Fig. 3. The vesicle with surrounding tissue removed from the body and seen from a more anterior point of view. More highly magnified. *C*, the abdominal integument; *T*, the tympanum; *N*, the chordotonal thread seen through the tympanum.

Fig. 4. Same as 3, but turned over and viewed from inner side, the inner half of the vesicle cut away, and more highly magnified. *C*, the abdominal integument; *Tv*, the remains of the tympanal vesicle; *T*, the tympanum; *N*, the chordotonal thread.

Fig. 5. A small piece of the tympanum, stained with haematoxylin and showing the nuclei.

Fig. 6. A section of the tympanum showing the nucleated projections and their processes.

Note.—The magnifications vary, but some idea of the actual sizes may be gathered from the thickness of the tympanum, fig. 6, which is ·008 mm. including the projections.

PLATE XXV.

Fig. 1. The chordotonal thread of the ♀ *Chrysiridia ripheus.* *Sh*, sheath of tracheal epithelium; *N*, nuclei of nerve; *Ln*, nuclei in first enlargement; *S*, *S*, scolopales; *Sn*, sheath nuclei.

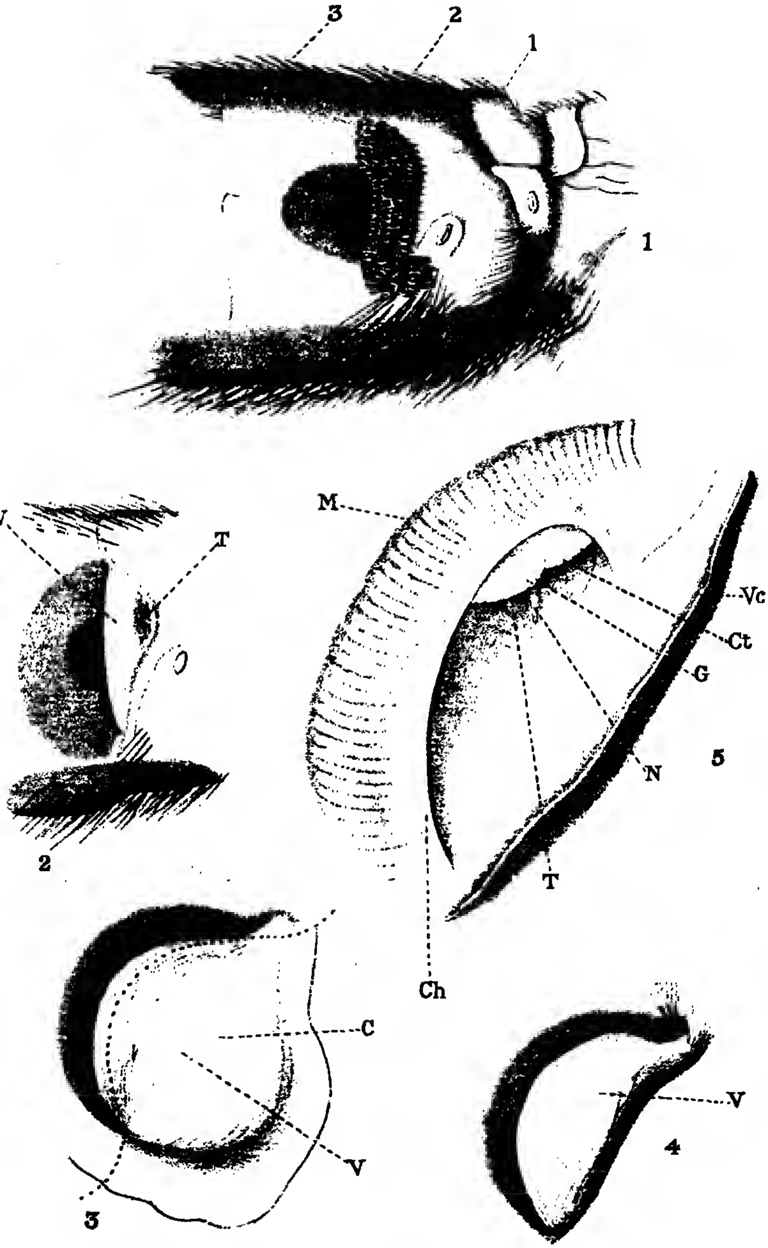
Fig. 2. First enlargement of ♀ chordotonal thread of another example. Lettering as before.

Fig. 3. Ditto from another example.

Fig. 4. The chordotonal thread of the ♂ *Chrysiridia ripheus.* *L*, Dark staining lines of the ganglion; *Ln*, large nuclei in ganglion; *Sh*, the sheath of tracheal epithelium; *Sn*, sheath nuclei; *Sc*, bipolar cell; *Scn*, nucleus of same; *S*, *S*, scolopales.

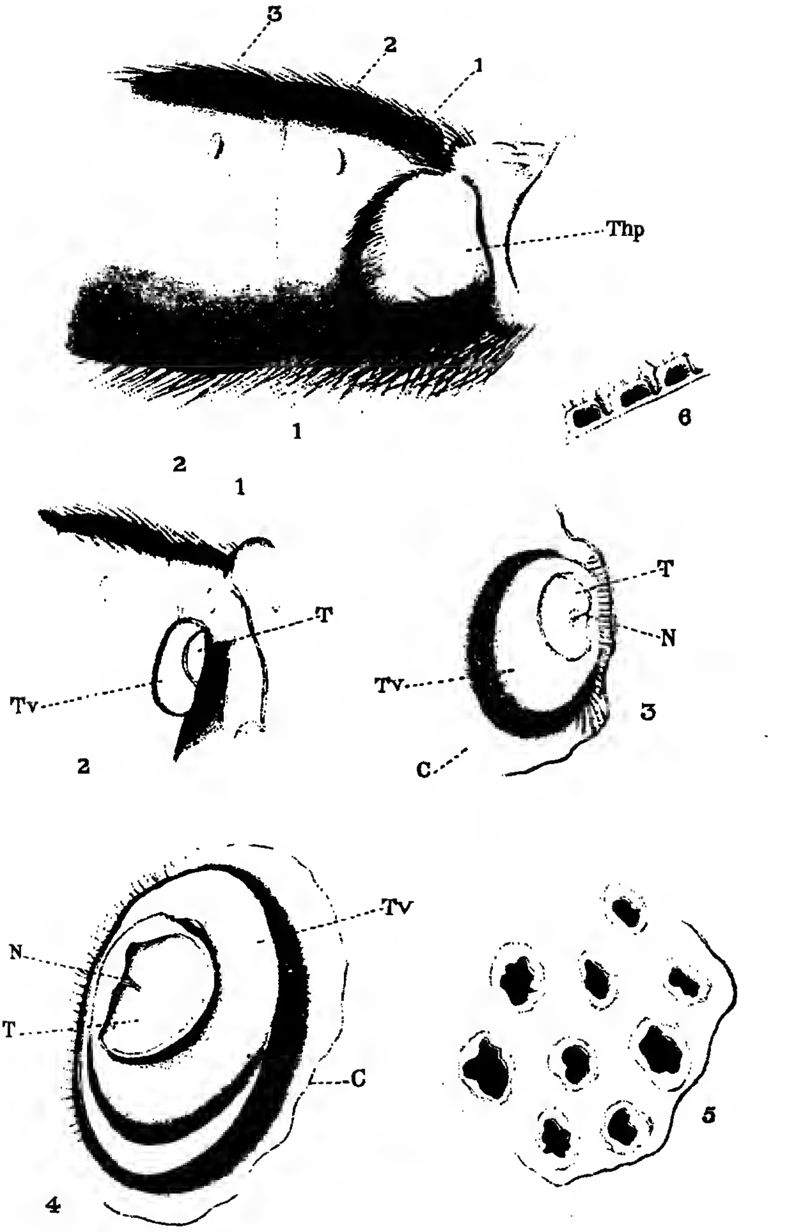
Fig. 5. Diagram of nerve connections. *Tg*, the thoracic ganglia; *Cn*, central nerve cord; *Va*, the tympanal organs; *Ba*, the auditory nerve branch (?).

Note.—Length of ♀ chordotonal thread ·222 mm. Length of a scolopale ·01 mm. Length of ♂ nerve without ganglion ·1 mm. Diam. of axis cylinder joining ♂ ganglion to chordotonal thread ·0005 mm. Length of ganglion in ♂ ·133 mm.



H.Eltringham, del. *J.T.R.Reid, Litho, E*

TYMPANIC ORGAN IN C. RIPHEUS. MALE.



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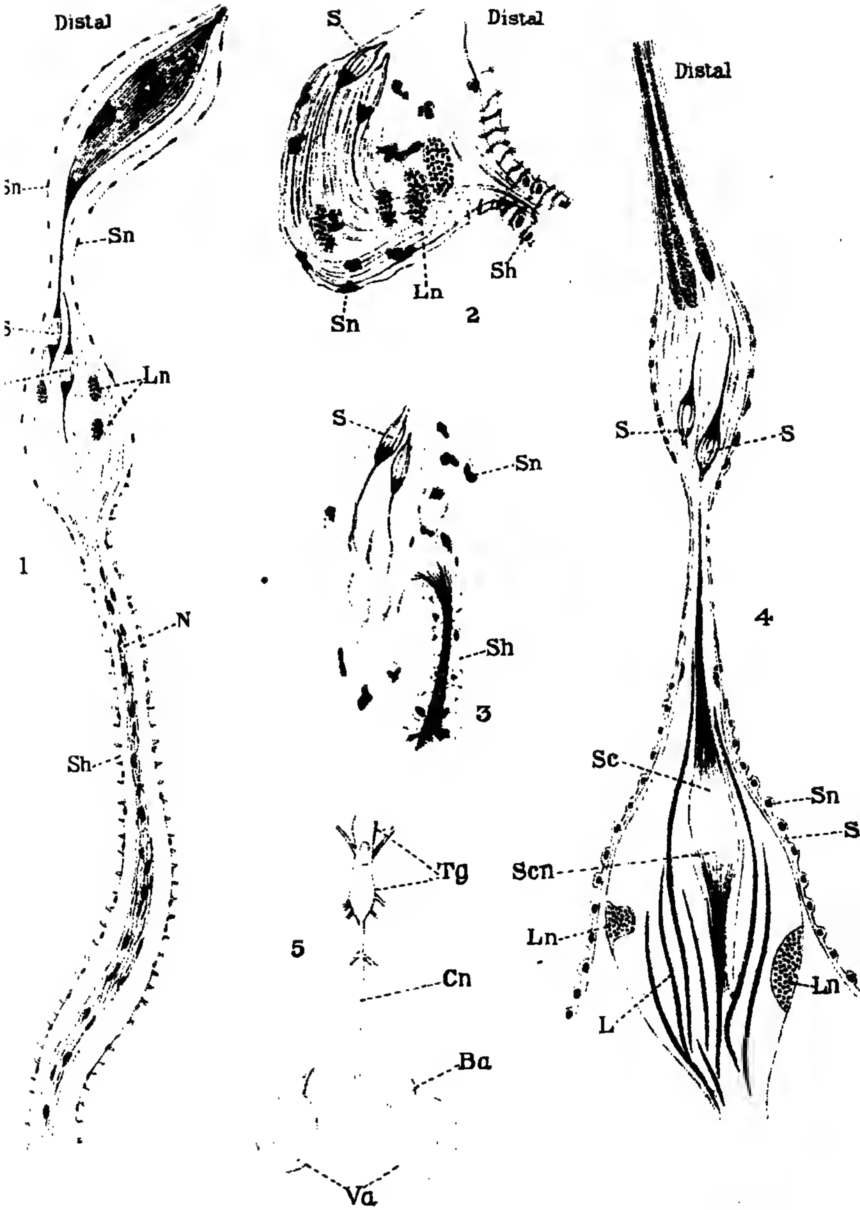
TYMPANIC ORGAN IN C. RIPHEUS. FEMALE.



Elltringham, del. *J. T. R. Reid, Litho. Edi*

TYMPANIC NERVES IN C. RIPHEUS.

XXII. *On the Oriental* Carabidae *of the "Reise Novara."* By H. E. Andrewes.

[Read Nov. 21st, 1923.]

In the course of its voyage round the world during the years 1857–9 the Austrian frigate "Novara" amassed a vast amount of material for subsequent examination. The species of Coleoptera numbered 1389, all of which were dealt with by Dr. Ludwig Redtenbacher, who described the new ones and determined the remainder, his Memoir on them appearing in the year 1867. This was a work of considerable magnitude, and the descriptions of the new species of Carabidae—all I am competent to speak of—were well done. It is not surprising, however, to find some mistakes in identification, as indeed the author himself seems rather to have anticipated. I have for long suspected the identity of some of the species mentioned, and, through the courtesy of Dr. K. Holdhaus, who has sent me from the Vienna Museum practically all the specimens I desired to see (for the loan of which I am much indebted to him), I have been able to make some corrections, an account of which, along with sundry notes, is set forth in the following pages. In addition to errors of identification, there are clearly some errors regarding locality, which I refer to in the appropriate places.

It may be of interest to note here that most of the specimens from Hong-Kong appear to have been given to the expedition by J. C. Bowring, the British Consul, who subsequently presented his large collection to the British Museum. The evidence of this lies in the labels, various specimens in the collection of the expedition bearing a number which in most cases corresponds with the number on similar specimens in the British Museum collection. Wherever I found such correspondence, I have put this number in a parenthesis after the locality.

The species of *Carabus* from North China are excluded, but my notes refer to all the other Eastern Carabidae, the species being numbered as in the Memoir.

29. **Casnonia chaudoiri** Boh. Hong-Kong (No. 760). I have not seen the type of this species, but the example agrees with the traditional identification.

30. **Ophionea cyanocephala** F. Hong-Kong. This is incorrect, the species being *O. interstitialis* Schm.-Goeb. (Faun. Col. Birm. 1846, 20).

31. **Drypta lineola** Dej. Manilla. Correct, but the species was first described by W. S. Macleay (Ann. jav. 1825, 27).

32. **Macrocheilus tripustulatus** F. Hong-Kong (No. 26). = *Macrochilus trimaculatus* Oliv. (Enc. Méth. Ins. ii, 1790, 347, t. 179, f. 11; Andr., Ann. Mag. Nat. Hist. (9), vi, 1920, 496–7 and 502).

33. **Planetes crucifer** Redt. Hong-Kong. = *Macrochilus astericus* White (Ann. Mag. Nat. Hist. xiv, 1844, 422), as was pointed out long ago by Chaudoir (Rev. et Mag. Zool. 1872, 172).

34. **Omphra hirta** F. Madras. I have not been able to deal satisfactorily with this genus at present, but I have seen the type of the species in question at Copenhagen, and I think the identification is correct (*vide* Trans. Ent. Soc. Lond. 1921, 163). The example is a ♂. The distribution seems to be confined to South India and Ceylon.

35. **Omphra pilosa** Klug. Ceylon. I have not seen the type of this species, but I have an example which Dr. W. Horn kindly compared with it. The identification here is certainly erroneous. The example is a ♀, and it seems to agree in most of its characters with *O. hirta* F., but the puncturation of the prothorax is denser along the sides and base, the elytra are a little wider and flatter, and the punctures along the sides of the striae not so close together. I have similar specimens both from Madras and Ceylon in my own collection and hope to refer again later on both to this example and the preceding one.

37. **Pheropsophus bimaculatus** F. Ceylon. This species should be referred to Linnaeus, with whose type, now in the collection of the Linnaean Society, the two examples from Ceylon agree well.

38. **Pheropsophus javanus** Dej. Java. Agrees with the type, which I have seen.

39. **Brachinus chinensis** Chaud. Hong-Kong. There is now no example of this species to be found in the Novara collection.

40. **Brachinus scotomedes** Redt. Hong-Kong (No. 1102, but I cannot find any corresponding number in the British Museum Collection). Bates (Trans. Ent. Soc. Lond. 1873, 305) and Chaudoir (Mon. des Brachynides,

p. 53) have both referred to this species, which appears to be fairly well known. The colour of the prothorax varies from testaceous to red, and it is sometimes quite broadly bordered with black. As far as I am aware it is confined to Southern China and Japan.

45. **Calleida lepida** Redt. Hong-Kong. Chaudoir thought that this species was possibly a variety of *C. chloroptera* Dej. (Mon. des Callidides, p. 112). I have recently seen the type of the latter species and think he is right.

47. **Metabletus glabratus** Dufts. Madeira and Manilla. I have not seen the Manilla specimen, which is not in a condition to travel. Dr. Holdhaus, who has made a special study of the genus *Microlestes* (to which Duftschmid's species belongs), informs me that, as might be expected, it has nothing to do with *M. glabratus*, but belongs to a new species nearly allied to *M. annamensis* Bates, though differing in the form of the oedeagus. It appears that in both species, as in the European *M. fissuralis* Rttr., there is in the ♂ on the middle of the last ventral segment a small granulate patch, absent in all the other Eastern species examined by him.

49. **Lebia chinensis** Boh. Hong-Kong (No. 192). Agrees with type.

53. **Mochtherus angulatus** Schm.-Goeb. Java. =*M. tetraspilotus* Macl. (Ann. jav. 1825, 25). For the synonymy *vide* Andr., Trans. Ent. Soc. Lond. 1919, 163.

54. **Mochtherus immaculatus** Redt. Java. The type is unique and I have seen nothing quite like it elsewhere. The genus is evidently *Dolichoctis*, but the author's comparison of it with *D.* (*Mochtherus*) *rotundatus* Schm.-Goeb. is misleading, for it is rather larger, not smaller, than that species, the form of the prothorax is very different, and the side border of the elytra is not very much narrower. In size and shape this species seems most nearly allied to *D. tetracolon* Chaud. The head is nearly similar, the frontal foveae slight but evident, with some faint cross striation, the eyes a little less prominent. Prothorax distinctly narrower, more contracted in front than behind, sides of base less reflexed, apex a little more deeply emarginate, front angles more acute, sides uniformly rounded, without trace of sinuation before the hind angles, which, though obtuse, are not rounded, the marginal setae practically on the border, the explanate margin rather narrower in front, but quite as wide behind, median line, transverse

basal impression, and foveae all a little less marked. Elytra similar in shape and in the striation, but a little more emarginate on each side at apex; of the pores on interval 3 I can only say that I think there is a very small one at about middle and on the middle of the interval.

M. immaculatus Chaud. (Ann. Soc. Ent. Belg. xii, 1869, 243) is quite another species, and for this I propose the new name of *M. asemus*.

58. **Anthia sexguttata** F. The example cannot be found. Dr. Holdhaus thinks, as I do, that a mistake has been made in attributing this species to Ceylon. I believe it to be confined to India.

64. **Scarites indus** Oliv. Ceylon. The specimen is lost, but there is no reason to doubt that it was correctly identified.

66. **Clivina lobata** Bon. This specimen has also disappeared, but if it came from Shanghai, as alleged, it seems extremely unlikely to belong to Bonelli's species, of which I have recently given some account elsewhere (Ann. Mus. Civ. Gen. 1922, 392).

69. **Craspedophorus cyaneus** Schaum. Hong-Kong (No. 481). The species belongs to Motchulsky's genus *Trichisia*. The specimen came from the Bowring collection, as did Schaum's type, and various examples now in the British Museum.

70. **Craspedophorus tomentosus** Dej. Another lost specimen. The species was first described under this name by Vigors (Zool. Mag. i, 1824, 537, t. 20, f. 1.), and is the same as *C. angulatus* F., on which I have previously commented at length (Trans. Ent. Soc. Lond. 1919, 125). Redtenbacher gives Java as the locality, but I think there is probably another error here, as the species seems to be confined to India and Ceylon.

71. **Craspedophorus mandarinus** Schaum. Hong-Kong (No. 480). I have not seen the type, but it also came from the Bowring collection. No doubt correctly identified.

72. **Craspedophorus (Paronomerus) fumatus** Schaum. Hong-Kong (No. 60). Agrees with type, also from the Bowring collection. Schaum's genus *Peronomerus*, to which the species belongs, is quite distinct from *Craspedophorus*.

73. **Epomis duvauceli** Dej. Hong-Kong (No. 1619). This proves to be an example of *Chlaenius nigricans* Wied. (Germ. Mag. iv, 1821, 110). So far as I am aware, Dejean's species is confined to India.

74. **Chlaenius bimaculatus** Dej. Hong-Kong. This is

C. lynx Chaud. (Bull. Mosc. 1856, iii, 199), treated by its author as distinct, though it is not more than a colour variety of Dejean's species.

75. **Chlaenius vulneratus** Dej. Hong-Kong (No. 277). This is a specimen of *C. micans* F. (Ent. Syst. i, 1792, 151) = *C. biguttatus* Motch. (Etud. Ent. iii, 1854, 63) = *subhamatus* Chaud. (Bull. Mosc. 1856, iii, 211). *C. vulneratus* Dej. is at present known only from India. The type of *C. micans*, which I have examined, is in the collection of the Paris Museum.

76. **Chlaenius hügeli** Redt. Calcutta. The label reads "Hügel 34." As pointed out by Chaudoir in his Monographie des Chléniens (p. 8), this species is identical with *Chlaenius xanthacrus* Wied. (Zool. Mag. ii, 1, 1823, 51; Andr., Trans. Ent. Soc. Lond. 1921, 170). It does not belong to the genus *Chlaenius* and in 1919 (Ann. Mag. Nat. Hist. (9), iii, 480) I proposed for it the new genus *Lomasa*.

77. **Chlaenius pulcher** Redt. Hong-Kong. Figured on Plate I, where the specific name, preoccupied by Nietner, is changed to *pericallus*. The species occurs elsewhere in China and also in Japan: it seems to be quite well known.

78. **Chlaenius orientalis** Dej. Ceylon. I have compared this specimen with examples of *C. quadricolor* Oliv. (= *orientalis* Dej.) and *C. laetus* F.: it appears to me to agree very well with the latter. There is no locality label, and I think this insect came from S. Africa and not from Ceylon.

79. **Chlaenius quadricolor** F. Cape of Good Hope. Like the last, this specimen belongs, not to the Eastern *C. quadricolor* Oliv. and F., but to the S. African *C. laetus* F.

80. **Rembus politus** F. Java. The specimen resembles in size the Javan examples of *Diplochila laevigata* Bates (Ann. Mus. Civ. Gen. 1892, 326) referred to in a recent paper of mine (Ann. Mag. Nat. Hist. (9), ix, 1922, 283), and I consider that it belongs to that species. The prothorax is not wider than in the typical form, but the hind angles are less rounded. The basal foveae are short, not reaching base, converging slightly forwards as in *laevigata*, not long and parallel as in *polita*; the sides of base are oblique as in *laevigata*.

It really differs from the other Javan specimens only in its rather narrower form and the slightly more evident

hind angles of the prothorax. An example in my collection from Sumatra is almost exactly similar.

81. **Rembus impressus** F. Manilla. This proves to be an example of *Diplochila colossus* Bates (Ann. Mus. Civ. Gen. 1892, 326). Notes on both these species, of which I have seen the types, will be found in my paper quoted above (pp. 285 and 286).

82. **Rembus zeelandicus** Redt. When Bates was describing his *Diplochila gigas* (Trans. Ent. Soc. Lond. 1873, 256) from China and Japan, he could see little difference between Redtenbacher's species and his own, but, as the former was alleged to come from New Zealand, he gave the Chinese species a new name. Von Heyden also thought the two species probably identical (Deutsch. Ent. Zeitschr. 1879, 330). In view of various other errors regarding locality I feel no doubt that *D. zeelandica* actually came from China; Dr. Holdhaus tells me that the type, which I have not seen, agrees well with a Chinese specimen, which I sent to Vienna some time ago and which he kindly compared with it.

88. **Cyclosomus flexuosus** F. Hong-Kong (No. 721). When referring to the types of the two Indian species of this genus, *C. flexuosus* F. and *C. suturalis* Wied. (Trans. Ent. Soc. Lond. 1921, 153 and 166), I mentioned examples from Hong-Kong as belonging doubtfully to the former. I have now compared considerable series of the two Indian forms with sixteen specimens labelled "Hong-Kong" and "China": these latter include examples in the British Museum, Cambridge University Museum, the "Reise Novara" example, and specimens in my own collection. As a result of this I think the Hong-Kong examples form a distinct species, for which I propose the name of *C. inustus*, though the structural characters separating it from *flexuosus* are not very marked. The new species is intermediate in size between the two Indian ones; in form it resembles *flexuosus*, the elytra proportionately a little shorter, with more rounded sides, the striae less deep; the pattern on the elytra similar to that of *suturalis*, but with an even narrower black discal band.

The differences between the three species may be shown in tabular form as follows:

1(2). Form very short oval, the front angles of prothorax acute and very little rounded. Colour light straw, side margins of prothorax pale testaceous; base of elytra to stria 5 on

each side brown, interval 1 and a rather narrow zigzag band on disk, extending on each side to stria 6 black. Average length 7·5 mm. . . . . *suturalis* Wied.

2(1). Form elongate-oval, front angles of prothorax distinctly rounded. Colour dark straw, side margins of prothorax dark testaceous to dark red.

3(4). Side margins of prothorax deep red; base of elytra on each side to stria 5, interval 1, a zigzag band on disk, broad at middle, but frequently narrowing to sides, where it generally reaches margin, a small spot on each side near apex, and a good part of interval 9 black. Average length 9·0 mm. *flexuosus* F.

4(3). Side margins of prothorax dark testaceous; elytra coloured as in *suturalis*, but with rather darker basal patch and narrower discal band. Average length 8·0 mm. *inustus* sp. nov.

In addition to the Chinese examples there are in the British Museum two specimens labelled "India"; I have found two others in the collection of the Indian Museum labelled "Chandipore, Orissa Coast (*F. H. Gravely*)," and one example labelled "Inde" in the collection of Mr. R. Vitalis de Salvaza.

Examples taken by Mr. R. Vitalis de Salvaza in Laos, at Pak Lay and at Dom Toum near Khone, belong to this species: one of those from Pak Lay is unusually dark in colour and is also very convex, with deep striae. Another example taken by Commander Walker in Namoa Island, Chusan Archipelago, is very small (7·0 mm.) and light in colour, the elytral pattern having almost disappeared. These seem to be varieties only of the same species.

89. **Orthogonius xanthomerus** Redt. The specimen received from Vienna is labelled as being probably the type, which is stated to have been taken at Hong-Kong by Ritter von Frauenfeld; as it bears the label "Frfld. 866," there is every reason to suppose that this is correct. It was compared by the author to *O. femoratus* Dej., and this no doubt induced Chaudoir, who did not know it, to put it near that species in his Monograph (Ann. Soc. Ent. Belg. xiv, 1871, 124). The group to which Dejean's species belongs is characterised by the presence of four setae at the apex of the ligula, and in *xanthomerus* the setae have disappeared: at the apex two large pores are visible, but I cannot detect any others, and I think the species will fit

best into Chaudoir's *insularis* group, near *O. dispar* Bates (Ann. Mus. Civ. Gen. 1892, 401). To facilitate its identification I give a brief comparison with that species.

Length: 13·5 mm. Width: 5·25 mm. (♂). *Colour* of upper surface quite black, the apical margin of the elytra narrowly testaceous; beneath piceous, antennae, labrum, palpi, and trochanters dark red, femora testaceous. *Head* narrower, more finely rugose and more uneven in front, frontal foveae not so deep or distinct; eyes a little more prominent, antennae rather thick, extending beyond base of prothorax, joint 1 shorter and stouter, palpi clearly truncate at apex. In both species the ligula is narrow and carinate beneath, more sharply so in *xanthomerus*, the paraglossae extending beyond it, rounded and minutely setose at apex. *Prothorax* a little wider and a little less contracted behind, front angles a little less, hind angles a little more rounded, explanate margin wider behind; median line and basal transverse depression a little less marked, the foveae rather deeper, a more distinct transverse furrow on each side of base, just inside the narrow border, surface more finely rugose, with some fine though sparse punctures along sides and base. *Elytra* similar in form, rather more rounded at apex, the disk less depressed, the border slightly more angulate at shoulder; the striation and puncturation almost identical, the punctures in the striae a little more evident, intervals equal in width, though rather more convex, the three pores on 3 similar, odd intervals each with an irregular row of minute punctures, 6 of same width as the other intervals (wider and curving outwards at middle in *dispar*), with two or three larger punctures near base, 7 narrow but of same width throughout, 8 finely but not closely punctate, the punctures of the marginal series on 9 more closely placed, a distinct row of punctures in the marginal channel at base, outside stria 9. Beneath the surface is smooth, the prosternal process bordered, the metepisterna elongate, the last ventral segment ♂ moderately excised in middle; protibiae not produced at apex, mesotibiae slightly curved, metatibial spurs long and sharp, joint 4 of tarsi only moderately emarginate, all claws pectinate.

In the British Museum there is a ♀ example of this species labelled "China, Bowring Coll." and probably coming from Hong-Kong. It agrees very well with the ♂ type, except that the prothorax is less narrowed behind, and the margin of the apical ventral segment is not excised. In this specimen the ligula appears more dilated at apex and is clearly bisetose.

91. **Sagraemerus javanus** Redt. Java. $=$ *Hypharpax (Harpalus) dentipes* Wied. (Zool. Mag. ii, 1, 1823, 54) $=$ *Hypharpax lateralis* Macl. (Ann. jav. 1825, 22). Other references are: Hope Col. Man. ii, 1838, t. 2, f. 3; Chaud., Ann. Mus. Civ. Gen. xii, 1878, 500; Veth Tidschr. Ent. 1910, 305; Andr., Trans. Ent. Soc. Lond. 1919, 152 and 158; *id.* Trans. Ent. Soc. Lond. 1921, 170.

In Redtenbacher's type the legs are dark, in the other two testaceous.

93. **Barysomus semivittatus** F. Hong-Kong (No. 733). This is one of the species of which I saw the type in Copenhagen (Trans. Ent. Soc. Lond. 1921, 160), and the Hong-Kong specimen agrees with my compared example. I am indebted to Dr. Schroeder of the Stettin Museum for an example of Nietner's *Oosoma gerstaeckeri* (Journ. As. Soc. Beng. 1857, ii, 147), taken by the author and, if not actually a cotype, equivalent to one. This also agrees with the Fabrician insect. The species ranges from Southern China, through Indo-China and India, to Ceylon.

94. **Bradybaenus ornatus** Redt. $=$ *B. festivus* Dej. (Spec. Gen. iv, 1829, 163) $=$ *B. exornatus* Nietn. (Ann. Mag. Nat. Hist. (3), ii, 1858, 181). I have compared the same example with the types of Dejean and Redtenbacher: I have also seen in the collection of the Stettin Museum an example of Nietner's species, taken by the author in Ceylon.

105. **Tetragonoderus quadrisignatus** Schönh. Hong-Kong (No. 724). I think correct, excepting that the author should be given as Quensel; I have not, however, seen the type. I do not know why this species should be so widely separated from No. 52, *T. biguttatus* Thunb.

106. **Stenolophus iridicolor** Redt. Hong-Kong. Tchitcherin pointed out more than twenty years ago the prevailing confusion among the Eastern species of this genus, which unfortunately still continues. He considered this species (Hor. Soc. Ent. Ross. xxxv, 1901, 246) as identical with *S. chalceus* Bates (Trans. Ent. Soc. Lond. 1873, 270) $=$ *S. difficilis* Hope (Trans. Ent. Soc. Lond. 1845, 15), which I find is not the case, while Bates (Trans. Ent. Soc. Lond. 1873, 269) was inclined to identify it with *S. proximus* Dej. (Spec. Gen. iv, 1829, 420). I have not seen Dejean's type, but I have compared a specimen of Bates's *proximus* with the type of *iridicolor* and find them to be distinct. Redtenbacher's species appears at first

sight to be an unspotted form of *S. smaragdulus* F., but the femora, apex of tibiae, and joint 2 of the antennae are dark, the palpi are less pointed, and the metatarsal joints are externally carinate. For the present I look upon the species as distinct.

129. **Dolichus flavicornis** F. Hong-Kong (No. 1228). This species has been identified with *D. halensis* Schall. (Naturf. Ges. Halle, i, 1783, 317), but I have seen neither of the types. It has a wide range in the palaearctic zone, extending from Central Europe to Japan.

138. **Anchomenus scintillans** Boh. Hong-Kong. I pointed out in a former paper (Trans. Ent. Soc. Lond. 1921, 180) that Bates' identification of this species was inaccurate, and that his *A. aeneotinctus* was really the same as Boheman's species. Redtenbacher has made a similar error of identification, and the *A. scintillans* of both authors must be referred to *A. chalcomus* Bates (Trans. Ent. Soc. Lond. 1873, 280).

147. **Callistus amabilis** Chaud. in litt. Hong-Kong. = *Callistomimus modestus* Schaum. I have already commented on this manuscript name (Proc. Zool. Soc. Lond. 1921, 243).

XXIII. Pseudacraea eurytus *and its Models in Eastern Uganda.* By G. D. H. Carpenter, D.M., B.Ch.

[Read Nov. 21st, 1923.]

Plates XXVI, XXVII, and Map.

The forms of *Pseudacraea eurytus* have been the subject of two previous communications to the Entomological Society. In the first * I showed how numerous were the varieties and transitional forms on Bugalla Island, Lake Victoria, as compared with the mainland, and that this was coincident with relative scarcity of the species of *Planema* serving as models.

In the second paper † some years later a complementary state of affairs was discussed, and it was also proved that among several small islands the predominant form of *Pseudacraea eurytus* on each island was associated with a numerical preponderance of its particular model among several species of *Planema* inhabiting that same island.

The present paper was commenced with a view to showing that a female form known as *poggeoides* predominates in the Eastern Province of Uganda owing to its particular model species of *Planema* there being also predominant. But examination of records of the large collections in the Hope Department of the Oxford University Museum and queries to the curators of other large collections have brought out other interesting points, so that the scope of the paper has been considerably enlarged.

The following are the subjects discussed.

I. The ♀ form *poggeoides* predominates over *tirikensis* in the Eastern Province of Uganda owing to scarcity in that locality of the black-and-white females of species of *Planema* which predominate in other localities.

II. Although the male *Planema macarista* is of somewhat the same type as both sexes of *Planema poggei* the latter is the true model for the form *poggeoides* of *Pseudacraea eurytus*.

* Trans. Ent. Soc., March 1914, pp. 606–645.
† *Loc. cit.*, July 1920, pp. 84–96.

III. *Planema poggei* at Entebbe has a somewhat different seasonal prevalence from *macarista*, occurring in greater proportion during the drier months. This difference is also noticeable in the respective mimics of the two species, namely *Pseudacraea kuenowi* and the form *hobleyi* of *Pseudacraea eurytus*.

IV. On the western border of Uganda appears a male *Planema* (*pseudeuryta*) which resembles a male *macarista* in whose hind-wings the white band is replaced by fulvous colour. A similar form also occurs there among other *Acraeinae*, and this colour-scheme has an appropriate mimic in a form of *Pseudacraea eurytus* which occurs in other parts of Uganda, but seems most plentiful on the western border. This form is now given the name *opisthoxantha*.

V. The distribution of *Planema aganice* form *montana* and its possible capacity of serving as a model in the Eastern Province of Uganda for the ♀ form *tirikensis* of *Pseudacraea eurytus*.

VI. The possible influence of the male of *aganice montana* upon the male of *Planema alcinöe camerunica*.

The collection which forms the basis of the present paper was made between January 10th–13th of this year close to the eastern border of Uganda. The locality was a small residual patch of forest known as the Chawo forest on the Malaba river between Mount Elgon and the northern coast of Lake Victoria (see Map).

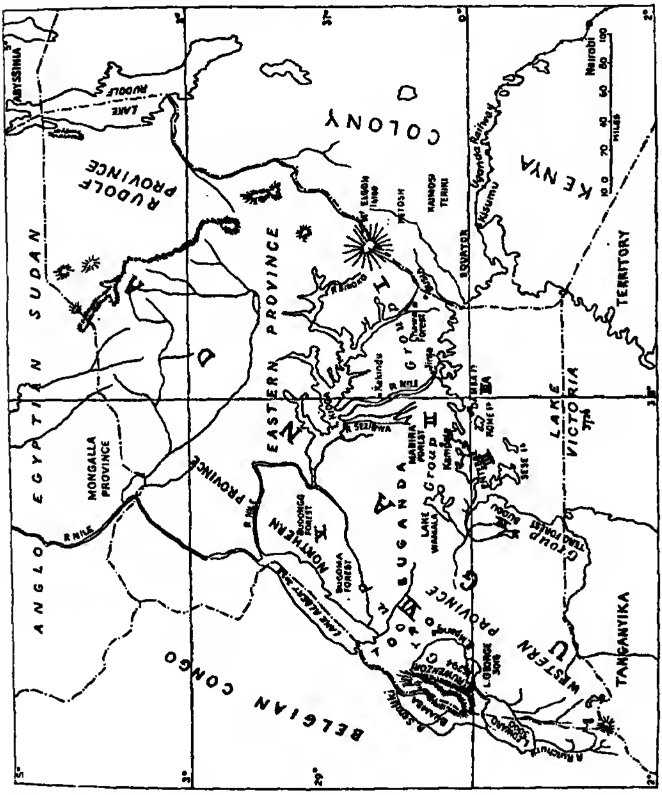
The specimens may be tabulated as follows :—

Species of *Planema*.	Forms of *Pseudacraea eurytus*.
poggei nelsoni, ♂ 3, ♀ 1.	*hobleyi*, ♂ 3.
aganice, form *montana*, ♂ 12, ♀ 1.	*poggeoides*, ♀ 2.
	opisthoxantha, ♂ 1.

It is at once apparent, to anyone who has studied this group of models and mimics, that the *female* mimics are of the usually scarce form *poggeoides*, while *Planema macarista* and *alcinöe* are absent, as is the ♀ form *tirikensis*, which at Entebbe is so abundant a mimic.

It will be noted that a new name is used here for a form of *eurytus*, viz. *opisthoxantha*. I propose that this name shall be used for the form which up till now has been alluded to as a *hobleyi* with fulvous hind-wings : in the typical *hobleyi* the hind-wing has a broad white basal bar, whereas in the

form *opisthoxantha* the white is replaced by brownish orange of the same hue as that on the fore-wing band (Plate XXVI, fig. 8). This form is analogous to a little-known species of *Planema*, namely *pseudeuryta* (Plate XXVI, fig. 7). In many specimens of the male of *Planema macarista* and its mimic *hobleyi* there is a transition to this type, the white



bar being broadly bordered by orange-brown (figs. 9, 10), and it is possible that further collecting on the western frontier of Uganda will reveal *macarista* in which the white is wholly replaced by the fulvous colour, as in *pseudeuryta*.

The specimens from Chawo forest are of particular interest as illustrating the change in appearance of a mimetic Nymphaline according to the geographical distribution of the species of *Acraeinae* which serve as its

models, different species fulfilling this function in different degree in different parts of Uganda, as elsewhere throughout the range of *eurytus*.

In order to obtain data for a critical examination of this point I have examined the careful records made by Major C. A. Wiggins, C.M.G., formerly Principal Medical Officer of Uganda, and by Dr. Sheffield A. Neave of the Imperial Bureau of Entomology, who have, especially the former, made very large collections in Uganda. There are also my own collections from the islands of Lake Victoria in 1914, and from Kakindu at the south end of the Tero forest on the west coast of Lake Victoria. I have grouped the localities as follows from east to west (see Map).

I. That part of Uganda lying to the east of the Victoria Nile, *i.e.* the Eastern Province. This group contains, besides my collection enumerated above; several small collections made by Dr. Neave in July and August 1911 between Jinja and Busia, on the southern slopes of Mount Elgon, and at Kakindu on the east bank of the Nile, between the south shore of Lake Kioga and Lake Victoria.

II. Localities in the Kingdom of Buganda which lie to the west of the Nile and north of Lake Victoria, but not including Entebbe itself, which is considered separately as III. Specimens in this group of localities were mostly collected by Dr. Neave in July and August 1911 and January 1912, but a few were collected by Major Wiggins at Kampala in April and June 1910. The localities are Kampala, "near Kampala," Mabira forest, Seziwa river, Lake Wamala, and "near Mityana."

III. Entebbe. Collections made by Major Wiggins in May to August 1909, April to December 1910, February to March 1911, and from July 1911 to May 1913. Also by Dr. Neave in July and September 1911 and January 1912.

IIIA. The islands of Kome and neighbouring small islets. Collections made by myself in 1914. It is unsuitable here to consider the collections from the Sese (= Sesse) isles in 1911–12, because the great abundance of transitional and varietal forms of Pseudacraeas at that time makes any classification and deductions therefrom valueless for the purposes of the present

paper. In 1914, however, owing to the increase in number of Planemas, the forms of *Pseudacraea eurytus* were well defined (see Trans. Ent. Soc. Lond., 1920, p. 85.)

IV. Sundry localities along the western border of Lake Victoria. Specimens were collected by Dr. Neave at the following localities in September 1911: "North-west lake shore," North Buddu, Western shore, Tero forest. I have also included here the results of a collection made by myself during 1915 at Kakindu in the southern part of the Tero forest, close to the old Anglo-German border.

V. The Budongo forest, which lies considerably to the north but not to the west of the last localities, on the high ground near the east coast of the north end of Lake Albert or Albert Nyanza. A collection was made here by Dr. Neave in December 1911.

VI. Localities along, or very near to, the western border of Uganda. Collections were made by Dr. Neave in October and November 1911 in the Daro forest (Toro), at the south end of Lake George, in the Mpanga forest (Toro) and Bugoma forest (Unyoro), and in the Buamba (Semliki) valley, at the western foot of the Ruwenzori range.

The total captures of the butterflies dealt with, which are the data upon which this paper is based, are tabulated on p. 474. The species and forms mentioned with the exception of *Pseudacraea kuenowi* are figured in the two plates, but a few words as to the colours will be necessary. The mimetic associations are of two or three colour-schemes. Firstly, that exemplified by a, b, e, f, wherein the dark brownish-black ground-colour is crossed by an orange band on the fore-wing and a white band on the hind-wing. It is to be noted that this colour-scheme is confined to the male sex of both *macarista* and *macaria hemileuca* Jord., but belongs to both sexes of *poggei*. In *hemileuca* the orange has a redder tint than in *macarista*, but it is so very scarce in Uganda that it can be of no value as a separate model for *Pseudacraea eurytus*.

I.—*Planema poggei* forms a subgroup in which the direction of the orange bar on the fore-wing is slightly more oblique than in the male of *macarista*, while its tint is slightly paler, enough to be noticeable to a careful observer when the

Table I.

Locality.	a_1	a_2	b	c	d	e	f	g_1	g_2	g_3	g_4	h	Total from each *locality.*
	Planema macarista E.M. Sharpe. ♂. Plate XXVI, fig. 1.	*Planema macaria* F., race *hemileuca* Jord. ♂. Plate XXVI, fig. 6.	*Pseudacraea eurytus* L., form *hobleyi* Neave. ♂. Mimics a. Plate XXVI, fig. 2. Plate XXVII, fig. 2.	*Planema pseudeuryta* G. & S. ♂. Plate XXVI, fig. 7.	*Pseudacraea eurytus* L., form *opisthoxantha* Carpenter. ♂. Mimics c. Plate XXVI, fig. 8.	*Planema poggei*, race *nelsoni* Gr. Sm. ♂ ♀. Plate XXVII, figs. 1, 3.	*Pseudacraea eurytus* L., form *poggeoides* Poulton. ♀. Mimics e. Plate XXVII, figs. 4, 5.	*Planema macarista* E. M. Sharpe. ♀. Plate XXVI, fig. 3.	*Planema alcinöe* Feld., race *camerunica* Auriv. Plate XXVII, fig. 9.	*Planema macaria* F., race *hemileuca* Jord. ♀. Plate XXVI, fig. 4.	*Planema aganice* Hew., race *montana* Butler. ♀. Plate XXVII, fig 10.	*Pseudacraea eurytus* L., form *tirikensis* Neave. ♀. Mimics $g_{1, 2, 3}$. Plate XXVI, fig. 5.	
I.	0	0	17	0	3	19	12	0	0	0	3	5	59
II.	9	0	1	0	0	21	0	7	1	0	3	2	44
III.	464	2	131	0	3	191	3	300	85	1	8	192	1380
III A.	70	0	19	0	0	34	0	18	33	0	49	17	240
IV.	10	0	9	0	0	24	7	7	1	0	0	1	59
V.	9	0	1	0	0	0	2	7	0	0	0	6	25
VI.	0	0	9	2	1	11	10	8	0	0	0	19	60
Total of each species or form	562	2	187	2	7	300	34	347	120	1	73	242	1877

butterfly is on the wing. The shape of the male fore-wing also is not so pointed at the tip (cp. Plates XXVI and XXVII, figs. 1). However, these species together form a well-defined synaposematic assemblage which is mimicked by two forms of *Pseudacraea eurytus*. One of these (b), only found in the male sex, is *hobleyi*, which accurately mimics the male of *macarista*; the other (f) is a female form. Its actual pattern is that of the black-and-white form *tirikensis* (h), but the white of the bar on the fore-wing is suffused with orange (cp. figs. 4 and 5, Plate XXVII, with fig. 5, Plate XXVI). The result is a pale orange bar which in colour and obliquity follows *poggei* as a model rather than the male of *macarista*; hence this form is known as *poggeoides*. It is to be noticed that in this case, which is exceptional among the *Planema-Pseudacraea* assemblages throughout the tropical African forests, the *Pseudacraea* female mimics both male and female *Planema*, the model being monomorphic.

It is worth remembering, when discussing *poggei*, that it is a model also for another *Pseudacraea* of a species different from *eurytus*, namely *kuenowi hypoxantha* Jord., whose sexes are alike as are those of the model.

Another colour-scheme is represented in the table by c and d, in which orange takes the place of white on the hind-wing. These butterflies, the male sex of *Planema pseudeuryta* and the form *opisthoxantha* of *Pseudacraea eurytus*, have been described above. It is interesting to note here that the female of *pseudeuryta* has not yet been distinguished: I am indebted for this information to Dr. Karl Jordan. We now come to the females (g) which are simply patterned in black and white, *macarista* being much the commonest in Uganda, and *alcinöe* the next most abundant, while *macaria hemileuca* is extremely rare; it is a modified West Coast species which extends its range into Uganda. *Planema aganice* in its northern and eastern race *montana* (g_4) is not so closely synaposematic with *macarista* as are g_2 and g_3, but one would think that it might be able to serve as a model for the form *tirikensis* (h) of *Pseudacraea eurytus*, which is such an excellent mimic of the female *macarista*.

The first point which I desire to establish by this paper is that the numerical proportions of the two female forms of *Pseudacraea eurytus* here dealt with, viz. *poggeoides* and *tirikensis*, follow the relative proportions of the species

serving as models; that is, that where orange-and-white models predominate the most abundant form of mimic is *poggeoides*, but where black-and-white models prevail *tirikensis* is more plentiful than *poggeoides*.

II.—A little complication is here introduced by the fact that the male of *macarista* is so near *poggei* in appearance that it might be justly considered to be likely to have an effect upon the proportional numbers of the mimic *poggeoides*. We will firstly consider it in this light and take the percentages of orange-and-white models to include the male *macarista*, and see how the percentage of orange-and-white female mimics agrees with that of the models.

TABLE II.

Locality.	Percentages of each of the two colour-schemes of model.		Percentages of mimics.	
	Orange-and-white.	Black-and-white.	*poggeoides.*	*tirikensis.*
I.	100	0	70	30
II.	79	21	0	100
III.	63	37	1·5	98·5
III A.	67	33	0	100
IV.	81	19	87·5	12·5
V.	56	44	25	75
VI.	58	42	34	66

It is not considered that these figures, with the exception of those from locality I, are of any value. In the Eastern Province, however, the absence of black-and-white female models has a striking parallel in the great preponderance of the usually scarce orange-and-white female mimic, the form *poggeoides*. My own captures in the Chawo forest gave an even more striking percentage, for I saw no *tirikensis* at all, both the females being *poggeoides*. Locality IV is also noteworthy on account of the unusually high proportion of *poggeoides* among the mimics.

Let us, however, examine a little more closely the models *poggei*, male and female, and the male *macarista*. For the following reasons it seems quite justifiable to exclude *macarista* as a model for *poggeoides*.

Firstly, on general grounds. Throughout the wonderful assemblage of species of *Planema* and forms of *Pseudacraea eurytus* it is the rule with sexually dimorphic butterflies that male mimics male and female mimics female. In

accordance with this rule *macarista* male is mimicked by the form *hobleyi* and its female by the form *tirikensis*, and the female orange-barred form of the *Pseudacraea*, *poggeoides*, is not a member of this clique.

Secondly, as was pointed out before, in colour and pattern *poggeoides* is not an accurate mimic of the male *macarista*: its orange bar is too pale in tint and too oblique in direction. Its proper model is certainly *poggei* both male and female.

Let us then disregard the male *macarista* from our reckonings and consider anew the percentages of the two types of model.

TABLE III.

Locality.	Percentages of models.		Percentages of mimics.	
	poggei, ♂ ♀.	*macarista*, ♀. *alcinöe*, ♀.	*poggeoides*.	*tirikensis*.
I.	100	0	70	30
II.	72	28	0	100
III.	33	67	1·5	98·5
III A.	40	60	0	100
IV.	75	25	87·5	12·5
V.	0	100	25	75
VI.	58	42	34	66

Of these localities No. V may perhaps be disregarded, as the data seem insufficient, for only twenty-five specimens were collected. At localities I, IV, VI the relative proportions do show that *poggeoides* is in greater number according to the numerical value of its true model *poggei*. In the Eastern Province there was nothing but *poggei*, and *poggeoides* was to *tirikensis* as 70 to 30. In the various localities along the western border of the great lake the proportions of orange-barred butterflies were high and black-and-white butterflies correspondingly low in both models and mimics. Similarly, in the small collections from the far western border of Uganda *poggeoides* was in fairly high proportion, while *poggei* formed just over half of the models.

On the other hand, at Entebbe, *tirikensis* follows its models *macarista* and *alcinöe*, for black-and-white butterflies predominated to an extent of 67 per cent., and the corresponding mimic formed 98 per cent. of the female forms of

eurytus entering these combinations. Similarly, in the collection made from islands opposite and near to Entebbe, where, however, no *poggeoides* were found, the small collections from parts of Buganda to the west of the Nile give no support to the argument, for while 72 per cent. of the models were of the orange-barred type there were no specimens of *poggeoides*. However, such a small number of specimens (44) can hardly be considered to overthrow a conclusion supported by a very much larger number from other localities, that, as with other forms of *eurytus*, *poggeoides* is most numerous where its model *poggei* is in greater abundance than in localities where the black-and-white models for the closely allied form *tirikensis* are predominant.

III.—We now come to the third point dealt with in this paper, namely, that there are some grounds for believing that the two species of *Planema*, *poggei* and *macarista*, have somewhat different seasonal prevalence, for the large collections made by Major Wiggins at Entebbe in the years 1909–13, together with smaller collections made by Dr. Neave in 1911, show the following figures. This relation was first remarked by Major C. A. Wiggins.

The following table gives the total number of each species for each month taken over a period of several years at Entebbe. The number of days' collecting for each month, however, was not the same for each month, being smallest when butterflies were fewest in the drier months.

Table IV.

	♂ *macarista*.	♀ *macarista*.	♂ ♀ *poggei*.	♀ *alcinõe*.	*hobleyi*.	*tirikensis*.	*poggeoides*.	*opisthoxantha*.	*kuenowi*.
Jan.	7	3	7	0	0	3	1	1	3
Feb.	0	11	14	1	4	5	0	0	1
March	1	2	5	0	1	4	0	0	5
April	20	19	10	1	4	10	0	0	3
May	27	34	11	4	11	10	0	0	3
June	46	24	15	6	11	18	0	1	0
July	102	58	35	7	31	40	1	1	6
Aug.	215	116	59	61	51	66	1	0	5
Sept.	36	25	21	4	9	24	0	0	8
Oct.	2	1	6	1	3	6	0	0	1
Nov.	5	2	4	0	5	4	0	0	0
Dec.	3	5	4	0	1	2	0	0	1
	464	300	191	85	131	192	3	3	36

From this table is constructed the following, which shows for the four butterflies *macarista*, *poggei*, *hobleyi*, and *kuenowi* the percentage of each individual species of the two pairs of *Planema* and *Pseudacraea* for each month.

TABLE V.

	Species of *Planema*.		Species of *Pseudacraea*.	
	macarista.	*poggei.*	*eurytus hobleyi.*	*kuenowi.*
	(Per cent.).	(Per cent.).	(Per cent.).	(Per cent.).
Jan.	59	41	0	100
Feb.	44	56	80	20
March	37·5	62·5	17	83
April	80	20	57	43
May	85	15	78	22
June	82	18	100	0
July	82	18	84	16
Aug.	85	15	91	9
Sept.	74	26	53	47
Oct.	33	67	75	25
Nov.	64	36	100	0
Dec.	33	67	50	50

From the table of percentages it is seen that the proportion of *poggei* to *macarista* is greatest from October to March and least from April to September. This corresponds fairly well with the seasons of greatest rainfall and greatest dryness, the heavy rains lasting from about the end of March to the middle or end of June, there being more rain again in November and December, and January to March being the driest time of the year. During the wettest months of the year, therefore, *poggei* has the smallest proportion to *macarista*, and the highest proportion during February, March, and October, which are the driest months.

Again, *poggei* is most abundant, as compared with *macarista*, when butterflies are fewest and when the struggle for existence is the most severe. So that it fulfils the functions of a model for *poggeoides* just at the time when the model is most needed, and will have a relatively more powerful influence at that time than the male *macarista*. This is another argument, in addition to those previously cited, for disregarding the male of *macarista* when consider-

ing the relative proportions of the models for the female forms *poggeoides* of *Pseudacraea eurytus*.

It is interesting to note here that the seasonal discrepancy between the two species of *Planema*, *macarista* and *poggei*, has a parallel in the two species of *Pseudacraea* which respectively mimic them, *eurytus* form *hobleyi* and *kuenowi*. In the last table, columns 1 and 3 and columns 2 and 4 should be read together. The number of *kuenowi* in proportion to *hobleyi* is greatest in the driest months of the year and least in June and November, although these figures are not conclusive on account of the small number of *kuenowi* captured and the small total number of specimens captured in the driest months. Thus a single specimen of *hobleyi* caught in January or a single *kuenowi* in November would have greatly altered the percentages. Nevertheless the data are suggestive. It is perhaps also worth noting that the three specimens of *poggeoides* at Entebbe were caught in dry months, January, July, and August, but more data are required.

The difference in seasonal prevalence between *macarista* and *poggei* should be borne in mind when considering the collection from the Chawo forest made in the driest time of the year. The complete absence of *macarista* might be a seasonal phenomenon and at other times of the year there might be a few to account for the presence of *tirikensis*, for Neave collected several in the Siroko valley (see Map) in August. But in reply to this it must be remarked that Neave found nowhere in the Eastern Province any *Planema* of the species now concerned other than *poggei* during the end of July and August. This brings up the question of the distribution of these species of *Planema* in Uganda and the surrounding countries.

Planema poggei occurs throughout Uganda, which would seem to be its headquarters. It ranges eastwards through Kenya Colony on the high ground to the east of Lake Victoria, northwards into the Mongalla province of the Sudan, whence a specimen taken by Kent Lemon at Issuru in April 1919 is in the Hope Department, and southwards into N.E. Rhodesia, whence specimens taken by Neave in the lower Kalungwisi valley in 1908 are in the National Collection.

The two species, *macarista* and *alcinöe camerunica*, with black-and-white females have a much more western distribution, and are properly West African species which,

like other examples of western fauna and flora, extend into Uganda. *Macarista* is the predominant model at Entebbe, *alcinöe* being less abundant. It is a very striking fact that these species, as models, almost cease at the Nile and are only very sparsely found to the east of that river.

The brothers Van Someren have taken *macarista* in the strip of forest which is continuous along the lake shore in the region of the Nile at Jinja for as much as fourteen miles to the east of the river, and also Dr. V. G. L. Van Someren has taken it at Kaimosi on the high plateau above the Kavirondo plain to the east of Lake Victoria, but not in abundance.

There are no specimens of *macarista* in the Hope Department of the Oxford Museum, in the Joicey Collection at the Hill Museum,* Witley, in the Tring Collection,† or in the National Collection,‡ from localities to the east of the Nile.

Regarding *alcinöe camerunica* Dr. V. G. L. Van Someren writes that he has taken it at Teriki (see Map) to the north-east of Lake Victoria, but I have no records of other specimens to the east of the Nile.

I think, in view of these data, that it may be said there are no black-and-white models for the form *tirikensis* to the east of the Nile, which is most significant in view of the much decreased proportion of this form and increase of *poggeoides* as we pass east of the Nile from Entebbe.

IV.—We now come to discuss the fourth point of this paper, namely, the male form *opisthoxantha* of *Pseudacraea eurytus* and its possible models. It will be remembered that a single specimen of this newly named form was taken in the Chawo forest, and Neave took two in the Siroko valley, where he remarked a strong fulvous suffusion in many of the *hobleyi*. The table also shows that three were taken at Entebbe and one on the western border of Uganda. There are grounds for thinking that the male form *opisthoxantha* on the western border of Uganda to some

* With the exception of one doubtful specimen about which Mr. George Talbot wrote to me in June: "There is one female *macarista* with the label 'Nairobi,' but I cannot guarantee it."

† Dr. Karl Jordan kindly wrote in June: "We have no white female of *Planema* from east of the Nile other than *aganice*, but in Usambara (N.E. Tanganyika Territory) a species occurs with orange male and white female" (*i.e.* the bars are of that colour). See *Planema adrasta* (p. 488).

‡ Personal inspection.

extent replaces *hobleyi*, and that it is a parallel case with *poggeoides* and its model on the female side.

What then is the model for *opisthoxantha*? Very little is known about the Planemas of the western border of Uganda beyond the fact that here several really western species may be met with more abundantly than in other parts of Uganda. Dr. Neave in 1911 and the writer with Major Wiggins in 1922 collected in the Buamba valley with very disappointing results as far as Planemas were concerned. Neave, however, among all his collections from locality VI, secured two specimens of a *Planema* male, which has been determined by Dr. Karl Jordan as *pseudeuryta*, a species quite distinct from *macarista*: its female appears to be unknown.

The appearance of this species is shown in Plate XXVI, fig. 7: it resembles a male *macarista* in which the white band of the hind-wing is replaced by orange-brown. It is evident from figs. 7 and 8 that *pseudeuryta* may be claimed as the appropriate model for the form *opisthoxantha* of *Pseudacraea eurytus*.

Unfortunately at present this species seems extremely rare in collections: there is only one in the Oxford Museum, one in the British Museum, and three at the Tring Museum (*teste* Dr. Jordan). But with increased knowledge it may be proved that further into the Congo this species has its headquarters and is predominant, and that only its fringe reaches Uganda. In any case, it is interesting that the form *opisthoxantha* which so well resembles it occurs on the western border of Uganda in somewhat greater proportion than elsewhere. Dr. Neave's collection in the Daro forest, Toro, in November 1911, gives most interesting figures, together with collections also made by him in the Buamba valley. The male *macarista* with white hind-wing bar was not taken, but one *pseudeuryta* was taken in Buamba valley and one in the Daro forest. The mimetic *opisthoxantha* is represented by one specimen from the Daro forest, where also three of the white-barred *hobleyi* were taken; no *hobleyi* were taken in the Buamba forest, nor in the Mpanga forest. Thus there was one *opisthoxantha* to three *hobleyi*, a higher proportion than has yet been found in other parts of Uganda.

Apart from the presence of *pseudeuryta* on the western border of Uganda there seems to be in that locality a change from white-barred hind-wing to brown-barred in other

species of *Acraeinae*. Most interesting, perhaps, is a form of *Acraea althoffi* Dew., whose male with brown-barred hind-wing has been taken by Neave in the western border, but nowhere else in Uganda. The only males of *althoffi* which Neave took in the Daro forest were both of this fulvous-barred form.

Acraea alciope in most parts of Uganda has a female of the form *aurivillii* with white-barred hind-wing greatly predominating; this form mimicking the orange-and-white-barred species of *Planema*. But a small proportion of the western Uganda form *tella* Eltr. (= *alicia* "♂" Gr.-Sm.) with fulvous-barred hind-wing is found in most localities of Uganda. On the western border, however, Neave found that in the localities comprising group VI there was only one female of the typical form *aurivillii* with white-barred hind-wing against nineteen of the female form *tella* and nine intermediate between the two. (There were also two forms with a white bar replacing fulvous on the *fore*-wing, but they are of no importance in this connection.)

The interesting facts discussed above show that it is of considerable importance, for the study of the changes in appearance of a mimetic species in different parts of its range, that large collections should be obtained from the country where Uganda meets the eastern edge of the great Congo forest.

Before leaving the fulvous hind-winged butterflies it is worth noting that the male of *Planema macarista* and *Pseudacraea eurytus* form *hobleyi* often show a fulvous border to the white bar of the hind-wing in various stages of development. Professor Poulton writes to me in the case of *macarista*: "this condition I found most common on the East of Uganda," and suggests that a total replacement of white by fulvous is probable in the west, the small amount elsewhere being partial persistence of a character fully developed in the west. Dr. Karl Jordan, however, writes to me that he knows of no case of a male *macarista* with completely fulvous hind-wing. It is possible that such a butterfly may yet be discovered in the Congo, and if as plentiful there as is its white hind-winged form in Uganda, would explain the greater prevalence of *opisthoxantha* on the western border of Uganda.

V.—We now come to the fifth subject of this paper,

namely, *Planema aganice* in its northern and eastern race *montana* and its possible influence on *Pseudacraea eurytus* in the eastern province of Uganda.

The collection made in the Chawo forest showed that, at any rate at that time, it was the commonest *Planema* there, twelve males and a female having been taken (see Plate XXVII, figs. 6 and 10). It is the black-and-white female with which we are now concerned. This species has for long been considered to be the probable model for the very scarce form *rogersi* Trim. of *Pseudacraea eurytus* occurring in the far east of Kenya Colony, but recent discoveries have supplied another species of *Planema* which is a more exact model.*

In South Africa *aganice* is the model for the form of *eurytus* there occurring known as *imitator* Trim., and in Nyasaland, in the region of Mount Mlanje, Neave discovered a local form of *aganice* known as *nyasae* Carp., closely resembled by a corresponding form of *eurytus* called *mlanjensis* Carp. If *Planema aganice* is common in the Eastern Province of Uganda it might therefore be expected that it would have influenced *eurytus* to produce a form slightly differing from the common *tirikensis*. But it has been shown above that although the black-and-white female form of the *Pseudacraea* does extend its range eastwards through Jinja to the Nandi escarpment (indeed, it derives its name from Tiriki (= Teriki), whence specimens first caught by Wiggins were described by Neave) it is, generally speaking, scarce to the east of the Nile. The reason, I think, may be that *aganice montana*, though a constant and important inhabitant of Kenya Colony, only spasmodically extends its range in great numbers as far to the west as Uganda.

The extensive collections made by Wiggins and Neave at Entebbe only secured eight females and one male out of a total of 1405 Planemas and Pseudacraeas. Further west no specimens are recorded, with a doubtful exception to be mentioned later.

When I collected on Damba island and the adjoining part of Kome (see Map) in Lake Victoria in 1911, and on Bugalla in Sese in 1912 and January to February 1913, I never saw this species. Great was my astonishment to find that in 1914 it was extremely abundant on the western part of Kome and the neighbouring islets. At first I

* See Appendix (p. 488).

thought that it had made its way up into Uganda from the east between 1912 and 1914, but further search into records showed that Wiggins had taken a male at Entebbe in the latter half of 1909 and six females in 1910. It therefore seems probable that *aganice montana* is a species which, based in the eastern parts of tropical Africa, can just exist in the eastern half of Uganda, where it enters into competition with the powerful *macarista-alcinöe* combination, but when circumstances are exceptionally favourable increases in great numbers. It has been in Uganda since 1899 (see below). The irregularity of its appearance may therefore explain why it has apparently had no effect as a model upon *Pseudacraea eurytus* east of the Nile.

Inquiries as to the distribution of *aganice montana* have revealed some interesting facts. Dr. Karl Jordan kindly informs me that at Tring there is one female collected at "Kayanja, Usoga" (Eastern Uganda) by Dr. Ansorge on March 7th, 1899, which is the earliest record I have secured for Uganda. There are also nine males and four females collected by Mr. Stanley Tomkins at Kampala before 1905, and specimens from Ukerewe island at the south end of Lake Victoria collected before 1905.

In the British Museum I saw a single male labelled "Entebbe 1908, Swinhoe." Neave took a most interesting specimen between Jinja and Busia in the Eastern Province of Uganda in July or August 1911, which seems to be of the previously mentioned form *nyasae* rather than *montana*. On the other hand, he also took *montana* in July 1910 on the north-west shore of Lake Nyasa, so that these two forms meet at the fringes of their distribution.

I am indebted to sundry friends for notes on the distribution of *aganice montana* in Kenya Colony and elsewhere. Canon St. Aubyn Rogers kindly wrote: "I should regard it as long established in the eastern districts of Kenya up to about 4000 feet. I have never met with it at Nairobi, and my impression is that it does not occur at such high elevation." (But see Dr. Van Someren's notes.) "I have a distinct recollection of taking it at Rabai (on the high ground behind Mombasa island) in January 1899 and in the hills near Voi in July 1899, and have since come to know it as a common species at both places, particularly in Taita."

Dr. Van Someren of Nairobi has kindly given me the following data :—

"Fairly plentiful at coast 1919–23 (Dalguba, Vanga, Shimba hills, Rabai).

"Fair numbers at Taveta, Kilimanjaro, 1919–21.

"Occasionally met with, mostly females, Nairobi, 1916–23.

"Very few, Mount Kenya (Meru, Chuka), 1919–23.

"Two undoubted females, Teriki, 1913.

"A few. Elgon W. and S.W., 1921–23.

"Very plentiful on both sides of Nile at Jinja, 1919–23.

"Fair numbers, Mabira forest, Uganda, 1919–23.

"Very few, Entebbe, 1920."

Dr. Van Someren makes the interesting observation that "Females from Uganda are smaller than those from the Kenya highlands, and these latter have the base of the hind-wing much paler, so that the spotting on the underside shows through distinctly; further, the hind-wing white bar is wider." These points are brought out quite clearly in a photograph which I received from Dr. Van Someren. He also wrote: "The form *meruana* with a buffy bar on the hind-wing is fairly common at Nairobi and at Kilimanjaro, but does not occur in my long series from Uganda." I may add that I have not found it in Uganda.

On these points Dr. Karl Jordan has commented as follows: "Our specimens from Kampala confirm Van Someren's remarks; but the spots of the hind-wing are sometimes quite distinct *above* also in this form. Our five females from Ukerewe island are intermediate between Van Someren's figures of specimens from Jinja and Nairobi; one of them with buff band on hind-wing, two others with the band more or less tinged with buff. A female from N.W. of Moshi" (at the foot of Kilimanjaro in Tanganyika Territory) "has the base of the hind-wing above darker and agrees with some of the Ukerewe specimens with white band on the hind-wing."

Mr. George Talbot kindly informs me that at the Hill Museum, Witley, there are specimens from "Tanganyika Territory without data, excepting two males from Albertville collected by T. A. Barns in June 1919. Barns did not take any of the form during his journey in N.E. Congo. There are specimens from Kenya Colony; Teita 3400 ft., Mau, Sept. '01, and one specimen taken by the late F. C. Selous on 12.4.07; also Kibwezi, April '07." Mr. Talbot further tells me of a most interesting specimen, "a single male from the Suffert collection with the locality

Accra, W. Africa." In response to further inquiries as to this unusual and most remarkable record Mr. Talbot tells me, "most of Suffert's things were eastern, but I always find his localities correct. I would not accept the Accra locality in the absence of further confirmation. It is curious, however, that this specimen should stand out from all the others in the series, and if there were more specimens I should call it a race. The specimen has a broader band on the fore-wing than there is in our series: the band on the hind-wing is more cleanly cut than in the Kenya specimens. This specimen is further characterised by the absence of the spot at the base of cellule 6 of the hind-wing: a form from Mpapua in Tanganyika Territory has this spot vestigial on the right hind-wing and absent on the other. It may be that this supposed West African specimen did come from Tanganyika Territory as an individual aberration." Such a remarkable record *if correct* appears to indicate that *aganice* has established itself in West Africa long enough to produce a form which has distinct characters. Yet, if this is so, how is it that no other West African specimens have been secured? Possibly the species may have reached the West Coast during one of its great waves of increase subsequently to die out as a result of severe competition with the numerous other species of *Planema* firmly established there.

These sundry facts show that, in this case, as in others when distribution is being studied, careful watch will produce results of much interest in the future and that further data are much wanted.

VI.—There is yet another point to be dealt with in connection with this species which brings us to the last subject of this paper.

I noticed in 1914 when collecting on Kome and other islands near it at the north end of Lake Victoria (see Map) that the male of *Planema alcinöe camerunica*, whose black-and-white female is one of the models for *tirikensis* (Plate XXVII, fig. 9), shows a considerable range of variation in depth of its grey-brown and orange coloration. The two specimens figured on Plate XXVII show about the extremes, fig. 7 being very pale, while in fig. 8 there will be noted considerable concentration of the dark tint at the basal half of the fore-wing and again just beyond the central pale area, which is thereby emphasised. If this figure be

compared with fig. 6, the male of *aganice montana*, it is evident that there is here a good basis from which a close synaposematic resemblance to *aganice* might be readily built up. The hind-wing would require concentration of colour so as to leave a paler band in the same manner.

So far as I know the significance of this variation in the male of *alcinöe* has not been the subject of comment before, except for a brief note (on pp. 87, 91) in my paper of 1920, and I call attention to it now for the sake of the distant future. For should *aganice* be able to establish itself in large numbers in close contact with *alcinöe* I confidently expect it to influence *alcinöe*, possibly responding itself also with synaposematic approach, so that there may be developed a definite form of *alcinöe* like *aganice*. Belief in the efficacy of Natural Selection, acting on material supplied by variation, to produce and maintain changes of this type gives me faith to make this prediction!

In the preparation of this paper Professor Poulton, as always, has helped me in many ways, and I am also much indebted to the friends whose letters are quoted in the course of the paper.

APPENDIX TO DR. HALE CARPENTER'S PAPER.

The *Planema* spoken of on p. 484 as being a more exact model for *Pseudacraea rogersi* was taken by Dr. W. A. Lamborn, in N.E. Tanganyika Territory. His collection reveals the interesting fact that, in the month previous to the few weeks in which a fine series of 11 males and 2 females of the *Planema*, mostly in fresh condition, was taken at Tanga in a locality described by him as "The Gorge," he captured in the Usambara Mountains one female *Planema* and, on the same day, a male and female of the rare form of *Pseudacraea eurytus* described by Trimen as *rogersi*, which hitherto has only been recorded from near Mombasa. Two days before he had taken another female of the *Pseudacraea*.

The *Planema* has been identified by Dr. Karl Jordan as *adrasta* Weym., and he kindly wrote to me as follows:—

"*Planema adrasta adrasta* Weym., Usambara.

"*Planema adrasta pancalis* Jord., one ♂ in Tring collection from Katanga, Tanganyika Territory.

"This is all I know of its distribution. Comparing our

solitary male of *pancalis* with the Oxford series of *adrasta* I find the difference to be *very* slight."

The precise data of Dr. Lamborn's captures are as follows :—

Locality.	1918.	*Pl. adrasta.*		*Ps. eurytus* f. m. *rogersi.*	
		♂	♀	♂	♀
Usambara Mts.: Amani, 3500 ft., to Makweli, 38° 42′ E.: 5° 2′ S.	Sept. 7				1
Usambara Mts.: 3000 ft., Kisara: 38° 43′ E.: 4° 50′ S.	„ 9		1	1	1
"The Gorge," Tanga	Oct. 6	2			
	„ 9	3			
	„ 10	3	2		
	„ 13	2			
	Nov. 1	1			
		11	3	1	2

Dr. Lamborn had noted that one of the male Planemas of Oct. 13th was chasing the black-and-white *Amauris niavius dominicanus* Trimen. The female *rogersi* of Sept. 7th was fresh, that of Sept. 9th a little worn, and the male very worn. The ♀ Planema of Sept. 9, a worn specimen, was considerably smaller than either of those taken at a much lower elevation at Tanga.

The importance of Dr. Lamborn's captures is that in *Planema adrasta* we seem to have the appropriate model for *rogersi*. Hitherto the only known *Planema* with black-and-white female occurring in the locality of *rogersi* was the northern form *montana* of *Planema aganice*. Although the pattern of the black-and-white female of *montana* is not unlike that of the female *rogersi*, the male is by no means a good model. In *adrasta*, however, we have a very good model for the female *rogersi*, which resembles the female *adrasta* extremely closely. The likeness between the respective males, however, is not so close, although far closer than that between *rogersi* and *montana*.

G. D. H. C.

Explanation of Plates XXVI–XXVII.

PLATE XXVI.

FIG. 1. *Planema macarista*, ♂. Entebbe, C. A. Wiggins, October 7th, 1912.

2. *Pseudacraea eurytus*, forma mimetica *hobleyi*, ♂. Entebbe, C. A. Wiggins, October 14th, 1912. Mimics 1.

3. *Planema macarista*, ♀. Entebbe, C. A. Wiggins, April 18th–20th, 1910.

4. *Planema macaria hemileuca*, ♀. Entebbe, C. A. Wiggins, March 7th–8th, 1911. A white spot towards the end of the fore-wing cell (and much larger on the right side in this specimen) is barely indicated in the figure. It is of importance as showing the essential similarity between the male and female patterns in this part of the wing.

5. *Pseudacraea eurytus*, forma mimetica *tirikensis*, ♀. Entebbe, C. A. Wiggins, September 3rd, 1910. Mimics 3.

6. *Planema macaria hemileuca*, ♂. Entebbe, C. A. Wiggins, August 31st, 1910.

7. *Planema pseudeuryta*, ♂. Daro forest, Toro, S. A. Neave, October 28th, 1911.

8. *Pseudacraea eurytus*, forma mimetica *opisthoxantha*, ♂. Chawo forest, Malaba River, E. Province, Uganda, G. D. H. Carpenter, January 10th–12th, 1923. Mimics 7.

9. *Planema macarista*, ♂. Bugalla Isle, Sese, L. Victoria, G. D. H. Carpenter, December 16th, 1912. White bar of hind-wing partially replaced by brown.

10. *Pseudacraea eurytus*, forma mimetica *hobleyi*, ♂. Bugalla Isle, Sese, L. Victoria, G. D. H. Carpenter, January 26th, 1912. Variety corresponding to 9.

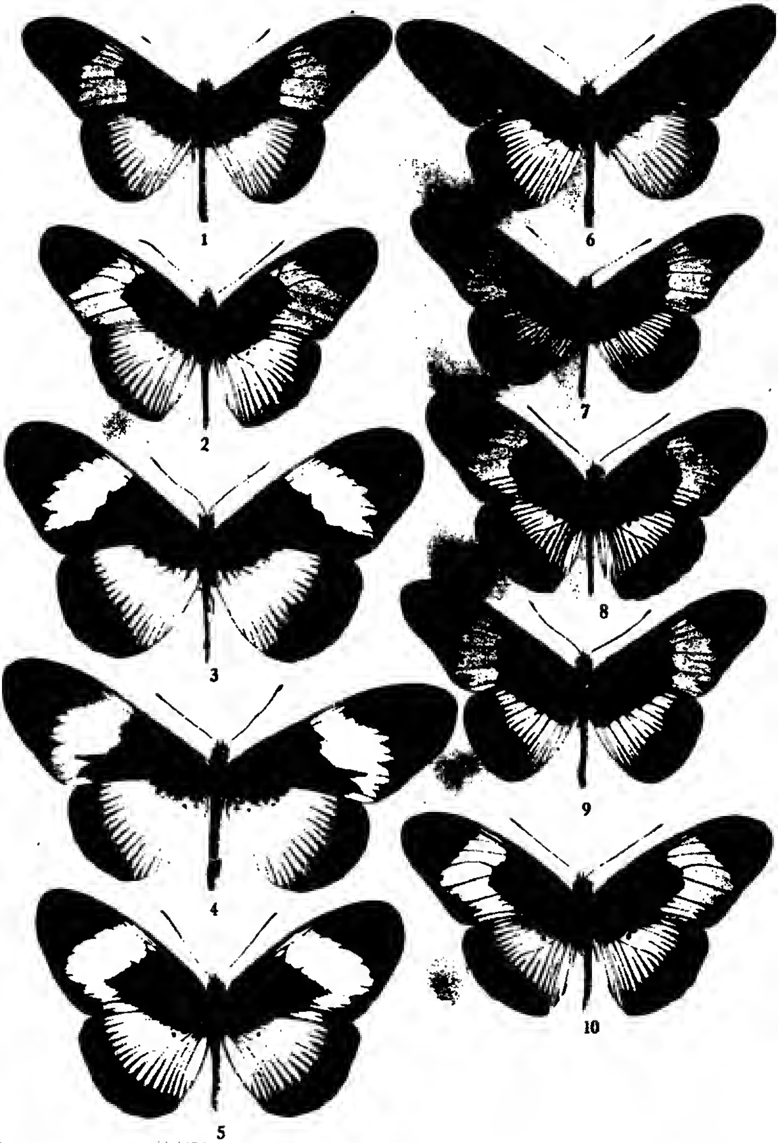
PLATE XXVII.

FIG. 1. *Planema poggei*, ♂. Chawo forest, Malaba River, E. Province, Uganda, G. D. H. Carpenter, January 10th–12th, 1923.

2. *Pseudacraea eurytus*, forma mimetica *hobleyi*, ♂. Data as 1.

3. *Planema poggei*, ♀. Data as 1.

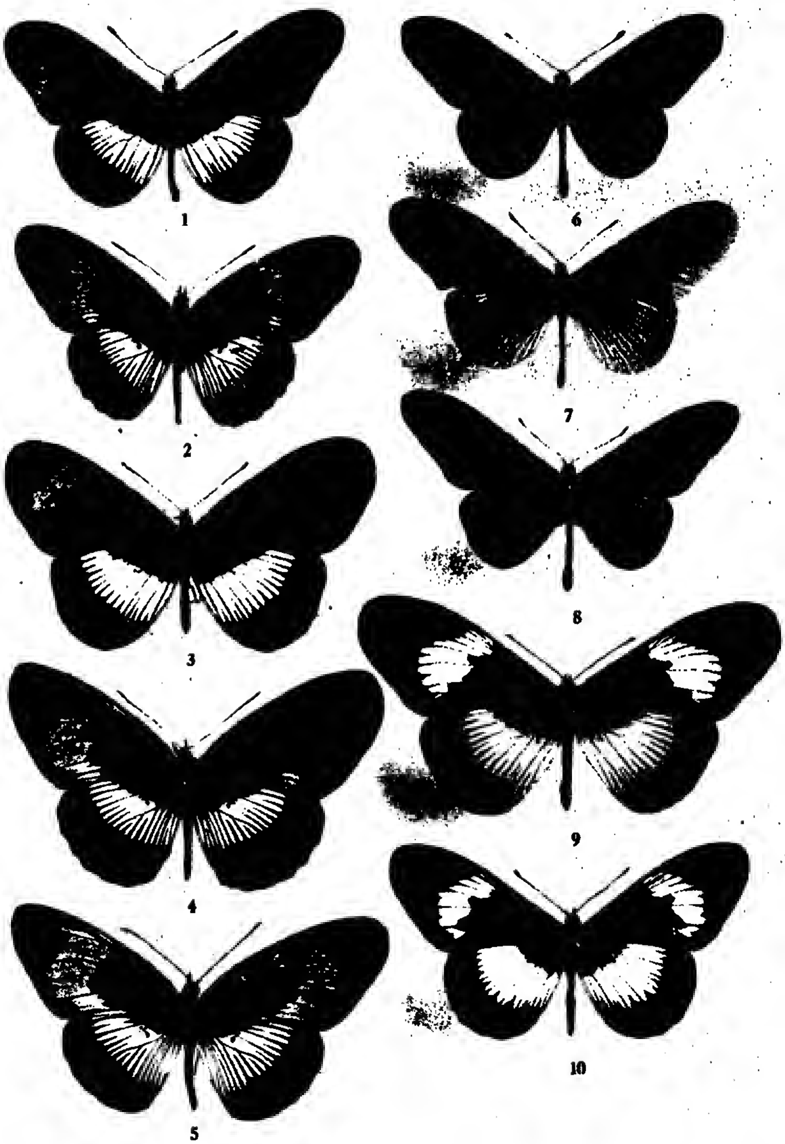
4, 5. *Pseudacraea eurytus*, forma mimetica *poggeoides*, ♀. Data as 1. Mimics 3.



A. Robinson, Photo *Vaus & Crampton*

The figures are about ⅝ nat. size.

SPECIES OF PLANEMA AND MIMETIC FORMS
OF PSEUDACRAEA EURYTUS



A. Robinson, Photo *Vaus & Crampton*

The figures are about $\frac{5}{8}$ nat. size

SPECIES OF PLANEMA AND MIMETIC FORMS OF PSEUDACRAEA EURYTUS, &c.

6. *Planema aganice*, race *montana*, ♂. Data as 1.
7. *Planema alcinöe*, race *camerunica*, ♂. Tavu Isle, Sese, L. Victoria, G. D. H. Carpenter, July 1st, 1914. A pale form.
8. *Planema alcinöe*, race *camerunica*, ♂. Bugalla Isle, Sese, L. Victoria, G. D. H. Carpenter, August 11th, 1912. A dark form possibly developing towards likeness to 6.
9. *Planema alcinöe*, race *camerunica*, ♀. Entebbe, C. A. Wiggins, August 23rd, 1910.
10. *Planema aganice*, race *montana*, ♀. Data as 1.

XXIV. *Notes on the Orthoptera in the British Museum. 3. Some less known or new genera and species of the subfamilies* Tettigoniinae *and* Decticinae.*

By B. P. Uvarov, F.E.S.

[Read December 5th, 1923].

Plate XXVIII and One Text-figure.

The present paper does not contain a complete list of the insects belonging to the two families named in the title and represented in the British Museum, but merely a collection of notes on some species insufficiently known as to their morphology, some remarks on synonymy, as well as descriptions of a number of new genera and species, and re-descriptions of certain Walkerian types. Thanks to the courtesy of Prof. E. B. Poulton I have been able also to study Dr. Malcolm Burr's fine collection of Palaearctic Orthoptera, recently acquired by the Oxford University Museum, and to publish here notes on some types by that author. My friend Prof. R. Ebner and the authorities of the Vienna Museum made it possible for me to examine certain types and other valuable materials from their collections, and I thank them here for the trouble they have taken in the matter. I am much obliged also to Dr. H. Krauss for the loan of types of *Gampsocleis spinulosa*, Kr.

Before proceeding with the notes in systematic order, I should like to point out that our present conception of the two subfamilies under discussion is hardly satisfactory. Indeed, they may be separated from each other by a single character only, namely, by the presence in *Decticinae* of the free plantulae on the first joint of the hind tarsi below, while members of the other subfamily are without the plantulae. The degree of development of the plantulae in the various genera of *Decticinae* is, however, very variable, and certain genera of the group *Drymadusae* possess only very short, almost rudimentary plantulae, which makes this character not quite reliable. Moreover, it must be assumed that the presence of the plantulae in

* See Trans. Ent. Soc. London, 1921, pp. 106–144; 1922, pp. 117–177.

Decticinae is an obvious adaptation to life on the ground, where the plantulae serve to secure a firmer footing before jumping, while the majority of *Tettigoniinae* are climbers on trees and bushes and seldom descend to the ground. Thus, it seems that the plantulae are a purely adaptational character acquired as a result of a change in habits, and, as such, can hardly be of great taxonomic value, and the subfamilies should, perhaps, be better united. This opinion finds further support in the statement by Chopard,* who has found no appreciable difference in the type of genitalia of both subfamilies, and by Boldyrev,† who established that the morphology of spermatophores and the whole process of copulation is exactly the same in representatives of *Decticinae* and *Tettigoniinae.* If, in face of all this evidence, I keep the subfamilies in this paper separated, I do it only for the convenience of readers.

Subfamily TETTIGONIINAE.

Caudell (Gen. Ins., Fasc. 138, 1912) catalogued five genera of this subfamily, but two more must be added now: *Hyphinomos* Uv. (Journ. Bombay Nat. Hist. Soc., xxviii, p. 74, 1921), with one species, *H. fasciata* Uv., from Tibet, and Australian genus *Pachysagella* described by Hebard as a member of *Saginae.*

TETTIGONIA L.

The type of this Linnean genus has been fixed already in 1815 by Leach (Edinburgh Encyclopaedia, p. 120) as *viridissima* L., which makes *Phasgonura* of Stephens (1835), founded on the same species, a pure synonym. All other reasons, fully dealt with by Karny (Zoolog. Annalen, ii, pp. 202–208, 1907,) leave also no room for any doubts as to the genotype of *Tettigonia,* and one wonders why Caudell (*l.c.*) still used *Phasgonura* in 1912.

To the eight species of *Tettigonia* listed by Caudell ‡

* Recherches sur la conformation et le dévelopement des derniers segments abdominaux cher les Orthoptéres. Théses présentés a la Faculté de Sciences des Paris, ser. A, No. 847, Rennes, 1920; pp. 137 and 233.

† Horae Soc. Entom. Ross., xli, No. 6, 1915, p. 227.

‡ *Locusta marginifera* of Walker from "Africa" belongs, probably, to an undescribed genus, but I refrain from describing a new genus after a single female specimen from an inaccurately known locality, and the species may be for the time kept in *Tettigonia.*

two more described recently must be added now, as follows :—

1914. *T. macroxipha* (*Phasgonura*) I. Bolivar, Memor. R. Soc. Esp. Hist. Nat., viii, 8ª, p. 234 (Morocco).

1914. *T. lozanoi* (*Phasgonura*) I. Bolivar, *l.c.*, p. 235 (Morocco).

One more new species is described below.

1. **Tettigonia orientalis**, sp. n. (Plate XXVIII, figs. 1, 2.)

♂. Related to *T. cantans* (Fuessly), but somewhat larger and with longer elytra. Brownish-green. Fastigium of the vertex with a feeble sulcus. Pronotum longer and more narrow than in *T. cantans*; its prozona cylindrical, smooth; front margin very feebly and broadly excised; first transverse sulcus distinct, in the shape of an obtuse angle, obliterate in the middle; submedian V-shaped sulcus not well developed; hind sulcus broad and irregular; metazona slightly raised and sloping, flat, indistinctly rugulose, almost twice as broad as long, with the median keel very low, but distinct; hind margin very broadly rounded. Prosternum with two long and pointed spines. Mesosternal lobes attenuate, pointed. Metasternal lobes triangular, with short conical attenuate apices. Elytra extending somewhat beyond the hind knees, broad in the basal half and attenuate apically; the radial vein branched in its middle. Wings distinctly shorter than the elytra, broadly rounded. Front and middle femora with 5–6 small brown spinules along the front lower carinae. Hind femora with 9–11 brown, black-tipped spines along each of the lower carinae. Last abdominal tergite with the median emargination reaching almost to its middle, somewhat narrower than each of the lobes, which are convex and distinctly longer than at the base broad. Cerci extending about as far as the ends of styli, with the basal half thickened and dilated and the apical part filiform, feebly incurved, armed before the middle with cylindrical, pointed, decurved tooth, which is about half as long as the apical portion of the cercus. Subgenital plate with a broad round emargination; styli subequal in length to the filiform part of cerci.

♀ (paratype). Elytra extending to the base of the apical third of the ovipositor. Ovipositor straight, with the lower margin feebly concave. Subgenital plate with two lateral keels, delimitating a pyriform strongly concave surface, divided by a sharp median keel; the hind emargination deep, oval, the lobes being well separated at their bases and closely approximated apically; seen in profile the lobes are with elliptical apices.

Length of body ♂ (type) 31, ♀ (paratype) 32; pronotum ♂ ♀ 9; length of elytra ♂ 33·5, ♀ 38; maximum width of elytra ♂ 11; hind femora ♂ 27, ♀ 28; ovipositor ♀ 32 mm.

One male type from Japan in the British Museum; one male and one female paratypes from the same country in Dr. Burr's collection (Oxford Museum).

This is probably the species mentioned by Brunner v. Wattenwyl (Prodromus Europ. Orth., p. 310) as an undescribed one from Japan which he has got in his collection. Dr. Burr also labelled his specimens as "*Locusta* sp. n.," but never published a description. It is not unlikely that *Locusta japonica* L. Brun. mentioned by Matsumura and Shiraki (Journ. Coll. Agric., Sapporo, iii, part i, 1908, p. 68) is the same species, but Prof. L. Bruner himself informed me that he has never described it.

The new species is well characterised by the relative dimensions, shape of elytra, form of the male cerci and of the subgenital plate of the female.

2. **Tettigonia viridissimo** (L.).

British Museum collection contains two males of this species from Seoul, Corea, which makes Brunner's record (Prodromus Europ. Orth., p. 308) that it occurs in Amurland quite certain.

PACHYSAGELLA, Hebard.

1922. *Pachysagella*, Hebard, Proc. Acad. Nat. Sci. Philadelphia, lxxiv, p. 273.

Hebard included this Australian genus in the subfamily *Saginae*, to which, in fact, one arrives when using for identification the existing highly artificial keys to subfamilies. In my opinion, however, the general habitus of the insect, feeble spinulation of its legs, as well as the structure of the sternal lobes, are characters which make its position amongst *Saginae* obviously unnatural, while no objection whatever may be raised against including it in *Tettigoniinae*, near *Hyphinomos* Uvar. and *Amphiestris* Fieb. Hebard knew only one species, *P. maculata* Heb., from S. Australia, but *Ephippiger australis* of Walker also belongs here, and it is quite incomprehensible why Kirby should include it in the genus *Chlorobalius* of *Decticinae*, to which it is strikingly dissimilar even in the general appearance.

1. **Pachysagella australis** (Walk.).

1869. *Ephippiger australis* Walker, Cat. Derm. Salt. B.M., ii, p. 238, no. 25.
1906. *Chlorobalius* (?) *australis* Kirby, Syn. Cat. Orth., ii, p. 190.
1908. *Chlorobalius* (?) *australis* Caudell, Gen. Ins., Fasc. 72, p. 7.

♂ (*selected type*). Cinereous. Face reddish-brown, coarsely punctured and rugose, more so in its lower part. Occiput velvety reddish-black, marmorated with cinereous. Pronotum with a twice constricted reddish-black velvety fascia along the middle; lateral keels blackish in parts; lateral lobes reddish-black in front and at the hind angle, marginated with pale buff below. Elytra greyish-testaceous, blackened in the middle portion. Abdomen greyish-brown, with an indefinite blackish fascia along the middle. Last tergite short, with a narrow round median emargination; cerci elongato-triangular, with the apex blunt triangular and a small incurved tooth above it.

♀ (*paratype*). Brownish. Face dark reddish-brown. Occiput indistinctly darkened. Pronotum with the median fascia not sharply defined, constricted once only; lateral lobes blackish, with a sharply defined pale brown marginal fascia, widened just behind the front margin and very narrow in the rest. Elytra unicolorous brown.

Length of body ♂ 26, ♀ 32; pronotum ♂ 9·5, ♀ 9; elytra ♂ 7·5, ♀ 3; hind femora ♂♀ 16; ovipositor 33 mm.

I am not quite certain whether the male and female described above are really conspecific, and I have selected the male as the type of the species.

The male differs strongly from *P. maculata* Heb. in the structure of genitalia. British Museum contains one male and two females, all from Swan River, Australia.

Drymadusa Stein.

1860. *Drymadusa* Stein, Berl. Ent. Zeit., iv, p. 257.
1908. *Drymadusa*, Caudell, Gem. Ins., Fasc. 72, p. 13.

The interrelations of the genera *Drymadusa*, *Paradrymadusa* Herm., *Ceraeocercus* Uvar. (Horae Soc. Ent. Ross., xxxix, 1910, p. 381) and *Bergiola* Stschelk. (Ann. Mus. Zool. Ac. Imp. Sc. St.-Pétersb., xii, 1907, p. 381; Revue Russe d'Entom., x, 1910, p. 50) are very imperfectly understood, and, since the number of species of the first two of them is increasing yearly, it would be premature to

attempt a revision of the whole group, to which some of the North American genera seem to belong as well. I shall, therefore, give simply lists of species of *Drymadusa* and *Paradrymadusa* described since Caudell's catalogue, as well as some notes on the synonymy of certain species.

Caudell gives a list of nine species of *Drymadusa* but *D. fletcheri* Burr is a *Gampsocleis* (see p. 524) and should be excluded from this genus, while one species, *D. recticauda* Werner, has been omitted by Caudell and two more have been described recently by me.

1901. *D. recticauda* Werner, Zoolog. Anz., xxvi, p. 530) (Armenia).

1916. *D. curvicercis* Uvarov, Bull. Mus. Caucase, x, p. 188, fig. 5 (Kurdistan).

1917. *D. pastuchovi* (*Paradrymadusa*) Uvarov, *l.c.*, xi, p. 286, fig. 2 (S.E. Transcaucasia).

Caudell has given incorrect reference to *D. magnifica* Werner, which should be read as follows :—

1901. *D. magnifica* Werner, Sitz. Akad. Wiss. Wien, cx, Abt. 1, p. 290 (Armenia).*

The species *D. guttatipenne* mentioned by Bolivar in his description of *D. affinis* (Ann. Soc. Ent. Belg., xliii, 1899, p. 601) has never been described.

D. mokanshanensis Caudell (Proc. Ent. Soc. Wash., xxiii, No. 2, p. 34) from China is a *Gampsocleis* (see p. 522).

PARADRYMADUSA Herm.

1874. *Paradrymadusa* Herman, Verh. z.-b. Ges. Wien, xxiv, pp. 199, 206.

1908. *Paradrymadusa* Caudell, Gen. Ins., Fasc. 72, p. 13.

Caudell lists six species of this genus, but *Pterolepis caucasica* F.W. does not belong here, and is, most likely, a *Pholidoptera*. The reference to the author and to the original description of *P. anatolica* is incorrect in Caudell's list, and should be read as follows :—

1901. *P. anatolica* Werner, Sitz. Akad. Wiss. Wien., cx, Abt., i, p. 291, pl. i, fig. 2 (Asia Minor).

The following species have been described since Caudell's catalogue :—

1907. *P. beckeri* Adelung, Hor. Soc. Ent. Ross., xxxviii, p. 45, pl. i, figs. 6, 6*a*, 6*b* (N. Caucasus).

* See also Ebner, Acta Soc. Entom. Čechoslov., xx, 1923, p. 2, figs. 1, 2.

1907. *P. retowskii* Adelung, Ann. Mus. Zool. Ac. Sc. St.-Petersb., xii, p. 403 (Crimea).
1910. *P. werneri* Adelung, Hor. Soc. Ent. Ross., xxxix, p. 349, pl. xv, figs. 7, 8; Uvarov, Bull. Mus. Cauc., xi, 1917, p. 290, fig. 7 (N. Persia).
1912. *P. maculata* Ebner, Ann. Naturhist. Hofmus. Wien, xxvi, p. 446, fig. 2 (N. Mesopotamia).
1914. *P. viridipennis* Stschelkanovzev, Mitt. Caucas. Mus., viii, pp. 101, 116, fig. 1 (E. Transcaucasia).
1916. *P. satunini* Uvarov, Bull. Mus. Caucas., x, p. 50; Ent. Mo. Mag. 3rd ser., vii, p. 48 (Transcaucasia).
1917. *P. expugnata* Uvarov, *l.c.*, p. 287, figs. 3, 4 (Armenia).
1917. *P. bocquilloni* Uvarov, *l.c.*, p. 289, figs. 5, 6 (Persia).
1917. *P. persa* Uvarov, *l.c.*, p. 290, fig. 8 (Persia).
1918. *P. jacobsoni* Pylnov, Mem. Inst. Agronomique Voronezh, iii, p. 136, figs. 1, 2 (W. Transcaucasia).
1921. *P. persica* (*Pholidoptera*) Chopard, Journ. Bombay Nat. Hist. Soc., xxvii, p. 54, figs. 21, 22, 23 (Persia).
1921. *P. qazvinensis* Chopard, *l.c.*, p. 55, figs. 27, 28, 29, 30 (Persia).
1922. *P. annulicornis* Uvarov, Ent. Mo. Mag., 3rd ser., viii, p. 87, fig. 2 (Palestine).

Two of the listed species are not valid, viz. *P. viridipennis* Stschelk., which is the same as *P. longipes* Br. W. (see Uvarov, Bull. Mus. Cauc., xii, 1919, p. 159; also, Ebner, Acta Soc. Entom. Čechoslov., xx, p. 6), and *P. jacobsoni* Pylnov, which is obviously a pure synonym of *P. sordida*, Herm.

P. persica Chop. has been described as a *Pholidoptera*, but it clearly does not belong to that genus, as the free plantulae of its hind tarsi are very short (as they are in *Paradrymadusa* and related genera, but not in *Pholidoptera*), and should be included rather in *Paradrymadusa*, at least provisionally; the structure of the sternal lobes, which are hardly developed and very broadly truncate, and of the hind tibiae, which are abnormally thick and short, suggests the necessity of making the insect the type of a new genus, but I refrain from doing it, until a revision of the whole group may be undertaken.

P. annulicornis, which I have described from Palestine, occurs also in Cyprus, whence there is one male specimen in Dr. Burr's collection (Oxford Museum).

Chlorobalius Tepp.

1896. *Chlorobalius* Tepper, Horn Scient. Exped. Centr. Austr., 2, p. 375.
1906. *Chlorobalius* Kirby, Syn. Cat. Orth., ii, p. 190.
1908. *Chlorobalius* Caudell, Gen. Ins., Fasc. 72, p. 7.

Two of the Walkerian species, viz. *Locusta decticoides* and *Decticus frontalis*, undoubtedly belong to this genus; the *Ephippiger australis* Walk., which Kirby also included in *Chlorobalius*, has nothing whatever to do with it, and belongs to *Pachysagella* (see above, p. 496).

Thus, only three known species remain in the genus *Chlorobalius*, but the real number should be far larger, as the *Decticinae* of Australia are yet practically unknown; even the British Museum collection contains one or two undescribed species, but in single specimens only and not sufficiently well preserved to justify describing new species.

The species described by Tepper, *Ch. leucoviridis*, is not represented in the Museum, as Kirby's note in the Catalogue, that it is represented by an immature specimen, is based on a larva of an unknown genus. *Ch. leucoviridis* seems to differ from both species of Walker by the coloration of the hind-wings, which are described as pellucid, with the veins pale, while they are tessellated with brown in *Ch. frontalis* and *Ch. decticoides*; there may be other morphological differences, but they are not to be deducted from Tepper's description, which is very unsatisfactory.

1. **Chorobalius decticoides** (Walk.).

1869. *Locusta decticoides* Walker, Cat. Derm. Salt. B.M., ii, p. 285.

The species has been described from as many as six co-types, three presented by Haslar Hospital, and three collected by Richardson. At present, there exist only five specimens, one of them being presented by Richardson, while the other four are labelled "New Holland" and presented by Haslar Hospital, and at least two different species may be distinguished amongst them. Since, however, Walker gives measurement of the expansion of the fore-wings, I think myself justified in narrowing my selection of the type to the only two specimens which are with expanded wings. These two specimens, again, differ from each other by their dimensions and coloration,

and may be not conspecific; I selected as the type of the species the larger of the two specimens and would add the following details to the original description :—

Fastigium of the vertex slightly widened apically, with an indistinct median sulcus. Front femora with 3–4 minute spines on the inner lower carina, while the outer one is unarmed. Middle femora with the lower carinae unarmed. Hind femora with 11–13 inner spines, and 6 outer ones. Subgenital plate acutely triangular, somewhat longer than at the base broad, convex, indistinctly carinated along the middle. Ovipositor reaching almost to the apex of the hind tibiae.

Length of body 34; pronotum 7; elytra 41 (?, the tips broken off); hind femora 32; ovipositor 40 mm.

The other co-types of *Locusta decticoides* Walk., as I have already said, hardly belong to the same species.

2. **Chlorobalius frontalis** (Walk.).

1869. *Decticus frontalis* Walker, Cat. Derm. Salt. B.M., ii, p. 264.

The exact locality of the single type (a female) is unknown, but it belongs to a collection from King George's Sound, New Holland. Here are some additional details of its morphology taken from the type :—

Fastigium of the vertex hardly broadened apically, with a distinct median sulcus. Front femora with 2–3 inner spines, unarmed outwardly. Middle femora unarmed. Hind femora with 10–12 inner spines, and 1–2 outer ones. Subgenital plate triangular, with the sides somewhat convex, as long as its base broad, thick, carinated along the middle. Ovipositor reaching about the middle of the hind tibiae.

Length of body 31; pronotum 7; elytra 28; hind femora 27; ovipositor 27 mm.

This species is separated from *Ch. decticoides* by the comparatively shorter elytra, hind femora and ovipositor, as well as by the spinulation of femora, and the shape of the subgenital plate.

LANCIANA Walk.

1869. *Lanciana* Walker, Cat. Derm. Salt. B.M., ii, p. 280.
1908. *Lanciana* Caudell, Gen. Ins., Fasc. 72, Decticinae, p. 38.

This genus belongs to the group *Rhacoclees* as defined by Caudell and to the same subdivision of it which includes three other Australian genera. The following characters must be added to the original description :—

First joint of antennae twice as long as broad. Fastigium of the vertex reaching a little beyond the middle of the first antennal joint, strongly compressed laterally, not more than half as broad as the third antennal joint. Pronotum subsellate, without the median keel. Prosternum armed with two moderately long spines. Mesosternal lobes apically attenuate, almost spiniform. Metasternal lobes with the apices tuberculiform. Front tibiae with three spines on the upper side, including the subapical one. Hind tibiae with two spurs beneath. The plantulae of the hind tarsi about half as long as the first joint. Last abdominal tergite transverse. Supra-anal plate small, triangular, impressed, included between two large, cordiform, vertically placed inter-cercal plates. Cerci simple, conical. (Subgenital plate of the type cannot be studied owing to its bad preservation.)

As appears from this description, the genus *Lanciana* shows some likeness in the external genitalia to *Neduba*, as it has also well-developed inter-cercal plates.

1. **Lanciana albidicornis** Walk.

1869. *Lanciana albidicornis* Walker, Cat. Derm. Salt. B.M., ii, p. 281.

Measurements of the type are as follows: Body 18; pronotum 4·5; elytra 21; wings 17; hind femora 20·5 mm.

Neduba Walk.

1869. *Neduba* Walker, Cat. Derm. Salt. B.M., ii, p. 250.
1893. *Tropizaspis* Brunner Wattenwyl, Rev. Syst. Orth., p. 187 (invalid, no species described).
1894. *Tropizaspis* Scudder, Canad. Entom., 26, pp. 178, 180.
1907. *Neduba* Caudell, Proc. U.S. Nat. Mus., 32, p. 295.
1907. *Neduba* Caudell, Gen. Ins., Fasc. 72, Decticinae, p. 8.

The reasons given by Caudell for separating the genera *Neduba* and *Aglaothorax* seem to me not convincing, as the shape of the pronotal keels is unreliable, while the

relative length of the hind legs can hardly be regarded as a character of generic value, the more so that there exists a species of *Aglaothorax*, viz. *A. diabolicus* Scudd., which has the hind femora as short as they are in the genus *Neduba*. On the other hand, the external genitalia are of the same type in both genera, and I should think that they might be better united, but I prefer to leave this question to the North American orthopterists, my personal acquaintance with the genera being very limited.

1. **Neduba carinata** Walk. (Plate XXVIII, fig. 3.)

1869. *Neduba carinata* Walker, Cat. Derm. Salt. B.M., ii, p. 251.
1874. *Arytropteris steindachneri* Hermann, Verh. z.-b. Ges. Wien, 24, p. 204, pl. 6, figs. 98–102.
?1907. *Neduba carinata* Caudell, Proc. U.S. Nat. Mus., 32, p. 296.

I have serious doubts whether the insect described and figured by Caudell under the name *N. carinata* is really conspecific with the type of that species, as the latter shows the following differences from the description by Caudell:—

Lateral pronotal carinae in the metazona distinctly convex, running into the hind margin without forming humeral angles with it ("pear-shaped" would be the best description of the shape of pronotum). Disc of the metazona very distinctly convex, both transversely and longitudinally. Hind tibiae armed above with 20–25 spines on each side. The apical projecting part of the last tergite is much broader than long, with the hind margin broadly rounded, irregularly undulated, and the outer angles not at all attenuate. Cerci projecting well beyond the apex of the last tergite. Intercercal plates, taken together, somewhat broader than the projection of the last tergite. No marked differences in the coloration or in measurements.

Of course, it is not impossible that some of those differences may be attributed to inexactness of Caudell's description, while others are due to the individual variability of the species, but it is a problem for the American orthopterists who may study long series of specimens, and I believe that the above description of the type will be helpful in that respect.

Group Arytropteres.

Caudell founded a special group to include a single genus *Arytropteris* Herm., characterised by the front tibiae bearing no outer dorsal apical spine. The same character, however, is common also to the genera *Dexerra* and *Requena* of Walker, *Thoracistus* of Pictet, *Umtata* of Péringuey, *Phlesirtes* of Bolivar and one undescribed genus found by me in the British Museum collection.

As regards the generic classification inside the group, it is in a great confusion, since the two Australian genera, *Dexerra* and *Requena*, of Walker have never been properly described; the genus *Arytropteris* has been confused by some authors with *Thoracistus*, which is a quite distinct insect, while the differences of *Umtata* from *Arytropteris* are very obscure. I hesitate to include another genus of Péringuey, *Aroegas*, in this group, as the author says nothing whatever on the armature of the upper side of the front tibiae; whether it means that they are entirely unarmed (and this would refer it to the group under discussion) I do not know, and am compelled to leave the genus out of consideration.

The six genera known to me, *i. e.* with the exception of *Umtata* and *Aroegas*, may be separated by means of the following key, which is a purely artificial one and does not aim at expressing their genetic relations.

1. (8) Hind tibiae with four terminal spurs beneath.
2. (5) Fastigium of the vertex distinctly separated from the fastigium of the front.
3. (4) Fastigium of vertex strongly compressed laterally, pointed (as seen from above), and but narrowly separated from the frontal fastigium. Pronotum cylindrical. Front tibiae entirely unarmed above. (Australia.) . *Requena* Walk.
4. (3) Fastigium of vertex not strongly compressed, seen from above obtusely truncate; very distinctly separated from the frontal fastigium. Pronotum with distinct lateral keels; its disc strongly widened and more or less flattened posteriorly. Front tibiae with two spines above. (S. Africa.) *Arytropteris* Herm.
5. (2) Fastigium of the vertex contiguous with that of the front.
6. (7) Pronotum as in *Arytropteris*. Male elytra somewhat visible behind the pronotum. (S.E. Africa.) *Anarytropteris*, g. n.

7. (6) Pronotum without lateral keels, strongly elongate backwards, perfectly concealing the elytra even in the male. (S. Africa.) . . . . *Thoracistus* Pict.
8. (1) Hind tibiae with two terminal spurs beneath.
9. (10) Front tibiae with two spines above. Hind femora more than twice as long as the pronotum. Free plantulae of the hind tarsi subequal to the first joint. (Australia.) *Dexerra* Walk.
10. (9) Front tibiae unarmed above. Hind femora not twice as long as pronotum. Free plantulae of the hind tarsi short. (E. Africa.) . . . . *Phlesirtes* Bol.

Requena Walk.

1869. *Requena* Walker, Cat. Derm. Salt. B.M., ii, p. 248.
1908. *Requena* Caudell, Gen. Ins., Fasc. 72, p. 37.

♀. First antennal joint with the inner margin dilated, especially in front, where it is rotundato-prominent. Fastigium of front separated from the face by a short arched transverse sulcus, distinctly separated from the fastigium of vertex. The latter strongly compressed laterally, almost lamelliform, seen in profile distinctly prominent forward, rounded in front, seen from above very narrow and pointed. Pronotum convex, both in transverse and in longitudinal direction (in the latter one but feebly); no trace of lateral keels; a scarcely perceptible fine line takes place of the median keel; front margin rotundately excised; a broad V-shaped sulcus in the front fourth; metazona much produced behind, rounded; lateral lobes much longer than high, broadly rounded, with a shallow, but distinct, humeral emargination. Prosternum with two cylindrical, obtuse spines. Mesosternal and metasternal lobes obtusely cylindrical. Elytra and wings absent. Front and middle femora with both the lower carinae minutely serrulated between some teeth of larger size. Front tibiae above unarmed, beneath on each side with six spines rapidly decreasing in size towards the apex. Hind femora moderately long, strongly thickened basally, armed with alternatively larger and smaller teeth along both lower carinae; knee lobes with the apices spinuliform, and armed with one sharp spinule each at the middle of the lower margin. Hind tibiae with four terminal spurs beneath. Free plantulae of the hind tarsi very short. Ovipositor somewhat longer than the body, very feebly recurved, almost straight.

1. **Requena verticalis** Walk.

1869. *Requena verticalis* Walker, Cat. Derm. Salt. B.M., ii, p. 249.

Dimensions of the female type from the Swan River, W. Australia, are as follows: Length of body 17; pronotum 7·5; hind femur 15; ovipositor 17 mm.

There is in the British Museum collection another female of this species, from Perth, W. Australia, but the male remains unknown. Another species of the same genus is represented also by a single female from W. Australia, but I do not consider it wise to describe a new species from that sex only.

Arytropteris Herm.

1874. *Arytropteris* Herman, Verh. z.-b. Ges. Wien, 24, pp. 198, 204.
1893. *Arytropteris* Brunner-Wattenwyl, Rev. Syst. Orth., p. 185.
1908. *Arytropteris* Caudell, Gen. Ins., Fasc. 72, p. 37.
1916. *Arytropteris* Péringuey, Ann. S. Afric. Mus., xv, p. 440 (*partim !*).

Brunner's remark (*l.c.*) that the genus *Thoracistus* Pict. is the same as *Arytropteris* Herm. is quite incomprehensible, since the differences between them are obvious even when their descriptions are compared. Péringuey's conception of the genus has been based, however, on Brunner's authority, and as he gives in his key and descriptions scarcely any morphological characters apart from the armature of femora, which is variable in this subfamily, it is practically impossible to see from his paper how many genera he has included in his "*Arytropteris*," though obviously there was more than one. The same reason makes it practically impossible to name species by the aid of Péringuey's paper. I know only one species of this genus.

1. **Arytropteris semiaenea** (Serv.).

1839. *Thyreonotus semiaeneus* Serville, Ins. Orth., p. 496.
1869. *Thyreonotus basalis* Walker, Cat. Derm. Salt. B.M., ii, p. 247.
1874. *A*[*rytropteris*] *angulosa* Herman, Verh. z.-b. Ges. Wien, 24, p. 204, pl. iv, figs. 31–36.
1902. *Pomatonota bipunctata* Kirby, The Entom., 35, p. 22.

1906. *T*[*horancistus* (*sic !*)] *semiaeneus* Kirby, Cat., ii, p. 182.
1906. *A*[*rytropteris*] *basalis* Kirby, *l.c.*, p. 182.
1906. *P*[*omatonota*] *bipunctata* Kirby, *l.c.*, p. 358.
1908. *T*[*horacistus*] *semiaeneus* Caudell, Gen. Ins., Fasc. 72, p. 17.
1908. *A*[*rytropteris*] *basalis* Caudell, *l.c.*, p. 37.

There is hardly any doubt that the species of Serville is identical with those of Walker and Herman. It may seem incredible that Kirby should make such a mistake as to describe the insect as a new species of *Mecopodinae*, but his types (an adult male, which I consider as the holotype, and a female larva) are before me; it is noteworthy that Kirby identified other specimens from the same (Distant's) collection as *A. basalis*.

The species is not constant in its colour characters, the general coloration varying from brown to ochraceous, and even to greenish, with dark (grey, brown and bronze) spots and markings more or less developed; at the same time, there is some variation in the shape of the pronotum, which in some specimens is somewhat shorter than in the others, but the shape of external genitalia remains quite constant. I believe that some of the species described by Péringuey are but colour varieties of *A. semiaenea*, but nothing can be said definitely until the types are properly redescribed.

Anarytropteris, gen. nov.

Very like *Arytropteris*, but differs from it in the fastigium of vertex being continuous with that of the front, which character I consider to be of generic value.

Genotype: *Anarytropteris fallax*, sp. n.

Anarytropteris fallax, sp. n. (Plate XXVIII, figs. 4, 5.)

♂. First antennal joint rotundato-prominent on its inner margin. Face transverse, with a shallow transverse impression near the clypeus; the bottom of the impression very finely rugulose; the rest of the face in scattered indistinct punctures. Fastigium of the front very indistinctly separated from the face, continuous with the fastigium of vertex (*i. e.* separated from it just by a fine line). Fastigium of vertex subequal in width to the first antennal joint, not sulcate from above. Pronotum shaped as in *Arytropteris semiaenea*, though the lateral keels are somewhat more pronounced;

lateral lobes rugulose and with minute tubercles, which form also a kind of denticulation along their lower and hind margins. Elytra scarcely visible behind the pronotum. Front femora with 2–3 spines on the front lower margin; middle femora with four spines on the same margin; knee lobes of both front and middle femora with short apical spines. Hind femora with 8–9 spines on each side beneath; knee lobes spined apically. Last tergite somewhat prominent behind, transverse, broadly semicircularly excised apically, the lobes acutely triangular, with the sides feebly concave. Cerci short, thick, with the apex incurved, beak-shaped, pointed. Subgenital plate lyriform, bicarinate, with the apex submarginate; styli short, cylindrical.

General coloration pale brownish-yellow, with a faint metallic shine. The underside of the first and second antennal joints, tarsi, some dots along the front margin of the pronotum, hind margin of its disc, two sublateral spots at base of the abdomen, transverse rows of dots on the hind margins of the tergites and very fine points scattered all over the abdomen, are black, or brown, with bronze shine.

Length of body 25; its maximal width 6·5; hind femur 23·5 mm.

The *type* is from Nyasaland (*Dr. Stannus*); another male (*paratype*) is from Umtali, Nyasaland (*Dr. G. A. K. Marshall*).

The paratype differs from the type in the lateral keels of the pronotum marked with bronze-black colour, but is quite similar in other respects.

THORACISTUS Pict.

1888. *Thoracistus* Pictet, Mém. Soc. Geneve, xxx, No. 6, p. 61.

1907. *Thoracistus* Caudell, Gen. Ins., Fasc. 72, p. 17.

1916. *Arytropteris* Péringuey, Ann. S. Afric. Mus., xv, p. 440 (*ad partim* !).

Pictet's description and figures of the genotype leave no doubt that the genus is quite distinct from *Arytropteris*. Its differences from the latter are as follows: Fastigium of the vertex much broader than the first antennal joint and continuous with the frontal vertex; pronotum without lateral keels, much produced behind and wholly covering the elytra even in the male; the lateral lobes of the pronotum almost vertical; their lower margin (at least in the male) with a very distinct humeral sinus.

Thyreonotus viridifer of Walker belongs to this genus, as well as, probably, some of the unrecognisable species described by Péringuey as members of the genus *Arytropteris*. British Museum collection contains two females which are not conspecific either with *T. viridifer*, or with *T. peringueyi*, and may be new (if not conspecific with Péringuey's species), but, as usual, I abstain from describing females.

1. **Thoracistus viridifer** (Walk.) (Plate XXVIII, figs. 6, 7.)

1869. *Thyreonotus viridifer* Walker, Cat. Derm. Salt. B.M., ii, p. 248.
1906. *T*[*horancistus* (*sic !*)] *viridifer* Kirby, Cat., ii, p. 182.
1908. *T*[*horacistus*] *viridifer* Caudell, Gen. Ins., Fasc. 72, p. 17.

This species is easily separated from the genotype by its perfectly smooth pronotum, which is also less produced and distinctly less convex posteriorly.

The dimensions of the type (male) are as follows: Length of body 19; pronotum 15; hind femur 21 mm.

DEXERRA Walk.

1869. *Dexerra* Walker, Cat. Derm. Salt. B.M., ii, p. 265.
1908. *Dexerra* Caudell, Gen. Ins., Fasc. 72, p. 38.

♂. First antennal joint short. Face strongly transverse. Fastigium of the front subquadrate, narrowly but distinctly separated from the fastigium of vertex; the latter more than twice as broad as the first antennal joint, seen from the front broadly triangular. Eyes relatively large, strongly prominent. Pronotum convex, short, truncate behind, without any trace of the keels; lateral lobes obliquely sloping, round, without humeral sinus. Elytra reaching the second tergite, almost rectangular in shape, not strongly inflated. Prosternum with two spines. Mesosternal and metasternal lobes in the shape of obtuse spines. All femora unarmed, except on the knee lobes, which are bi-spinulose on the front legs and unispinose on others. Front tibiae short and thick, with two upper spines, without an apical spine, and with fine spines on each side beneath. Hind tibiae with two terminal spurs beneath. Free plantulae of hind tarsi almost as long as the first joint. Last tergite strongly transverse, broadly triangularly emarginate behind. Supra-anal plate not visible. Cerci short, conical, with a strongly recurved

tooth at the base. Inter-cercal plates very long and narrow, sabre-shaped, crossed. (Subgenital plate in the type deformed.)

1. **Dexerra turpis** Walk. (Plate XXVIII, fig. 8.)

1869. *Dexerra turpis* Walker, Cat. Derm. Salt. B.M., ii, p. 266.

Dimensions of the type (male) of this extremely interesting insect are as follows: Length of body 13·5; pronotum 5; elytra 1·5; hind femur 13·5 mm.

PHLESIRTES I. Bol.

1922. *Phlesirtes* I. Bolivar, Voyage de Baron M. Rothschild en Éthiopie, etc., p. 203.

I. Bolivar founded this genus on *Xiphidion merumontanum* Sjöst., and he suggested that it may belong to *Decticinae* but hesitated to state it definitely, on account of the front tibiae being unarmed above. I think, however, that the latter character is of less importance than the development of the free plantulae of hind tarsi which in *Phlesirtes* are perfectly typical for *Decticinae*, and this makes it impossible to include the genus in *Conocephalinae*, in spite of superficial resemblance of the insect to *Xiphidion*.

Three more species of *Xiphidion* described by Sjöstedt, *meruense*, *kilimandjaricum* and *kibonotense*, also probably belong to *Phlesirtes*, and the British Museum collection includes one new species described below, as well as a female of a probably undescribed species, which I find useless to describe until the male is known. Thus, it appears that the genus is rich in species, although the small size of these insects and their larvae-like appearance are obviously a cause for their being neglected by collectors. All known species are East African in distribution.

1. **Phlesirtes merumontanus** (Sjöst.).

1909. *Xiphidion merumontantum* Sjöstedt, Wiss. Ergebn. Kilim. Exped., iii, 17, p. 139, pl. vi, figs. 9, 9*a*, 9*b*.

1922. *Phlesirtes merumontanus* I. Bolivar, Voyage de Baron M. Rothschild en Éthiopie, p. 203.

British Museum collection contains one male and one female of this species from Ngabana, British East Africa.

2. **Phlesirtes brachiatus**, sp. n. (Plate XXVIII, figs. 9, 10.)

Pale castaneous. Face pale yellowish. Head and pronotum shining, with a darker broad median fascia not reaching the hind margin of pronotum and included between two narrow pale fasciae, not sharply defined; vertex also with a narrow pale median line. Abdomen with broad blackish lateral fasciae. Last tergite blackish-brown, with two indefinite pale sublateral spots; posterior emargination broad, rectangular; lobes narrow, much longer than broad, decurved. Cerci cylindrical, granulated; the preapical branch longer than its distance from the base, bisinuate, distinctly compressed, rotundato-triangular in the cross-section, somewhat dilated beyond the middle, with the apex suddenly attenuated. Subgenital plate blackish-brown, large, oval, with an irregular narrow sulcus along its middle; hind margin rectangularly excised, with the lobes rounded. Hind femora pale, only knees slightly darkened.

Length of body 10; pronotum 5; elytra (visible portion) 1·5; hind femora 10·5 mm.

Described after one male from British East Africa (*R. Ford*).

Ph. brachiatus is very near to *Ph. merumontanus*, but, apart from some differences in coloration, the posterior emargination of the anal tergite is distinctly broader in the new species, while its lobes are considerably longer and decurved; the branch of the cerci is in *brachiatus* much longer and not round, as in another species, but very peculiarly compressed.

ATLANTICUS Scudd.

1859. *Orchesticus* Saussure, Revue et Mag. Zool., 2 ser., xi, p. 201 (praeoccupied !).

1893. *Engoniaspis* Brunner, Ann. Mus. Genova, xxxiii, p. 185 (invalid, no species included !).

1893. *Amuria* Brunner, *l.c.*, p. 185 (both invalid, containing no species, and praeoccupied in Lepidoptera, by Staudinger, 1887).

1894. *Atlanticus* Scudder, Canadian Entom., xxvi, pp. 177, 179.

1914. *Amuria* Pylnov, Revue Russe d'Entom., xiv, p. 109.

1916. *Atlanticus* Rehn and Hebard, Trans. Americ. Entom. Soc., xlii, pp. 33–100.

As the full history of this genus has been given by Rehn and Hebard in their excellent monograph of the American species (*l.c.*), I shall point out only one more synonym missed by those authors. This is *Amuria* of Brunner, which genus, though described in 1893, did not become valid until 1914, when Pylnov (*l.c.*) made known its first species; the name is, besides, praeoccupied and cannot be used. That the genotype of *Amuria*, which is, of course, *A. brunneri* of Pylnov, belongs to the genus *Atlanticus* is beyond any doubt, and since two more species are known now from Eastern Asia, *A. palpalis* Rehn and Hebard, 1920, and a new one described below, it is clear that the genus shows a very remarkable distribution. Indeed, Rehn and Hebard are of the opinion (*l.c.*, p. 43) that the genus *Atlanticus* in N. America is of austral origin, its centre of distribution being in the south-eastern part of the United States, while but two species are found in the northern Mississippi Valley, and but one reaches Arkansas. On the other hand, the three Asiatic species are known from China and from the Ussuri region, which makes the two areas entirely disconnected. It would be, of course, premature to speculate on the reasons of such close affinities between the austral faunas of N. America and that of the Chinese region, but the fact is still more emphasised by the circumstance that the whole subfamily *Decticinae*, as its distribution shows, is a very ancient group and undoubtedly a relic of some widely distributed fauna.

Of the nine American species listed by Rehn and Hebard one only is represented in the British Museum, *A. americanus*, the only specimen of it being the type of *Decticus derogatus* Walk., the synonymy of which has been thus quite correctly established by previous writers.

The Asiatic species are three in number, as follows :—

1. **Atlanticus brunneri** (Pyl.).

1914. *Amuria brunneri* Pylnov, Revue Russe Entom., xiv, p. 109, figs. 3, 4, 5.

Pylnov described this species, not represented in the collections studied by me, from the Ussuri region. It is characterised by the fairly long male cerci, distinctly incurved and armed with a premedian tooth, and by the straight, apically decurved ovipositor.

2. **Atlanticus sinensis**, sp. n. (Plate XXVIII, figs. 11, 12.)

♂. Face distinctly reclirate; fastigium of the vertex, seen from above, distinctly narrower than the horizontal diameter of an eye; seen from the front it is truncate apically, the apex being narrower than the basal antennal joint. Maxillar palpi with the apical joint distinctly incrassate apically, about one-third again as long as the subapical one. Disc of the pronotum somewhat convex in the prozona and flat in the metazona, constricted at its apical fourth, the width here being about one-half of the maximum width, which is at the very hind margin; the first sulcus shallow, but distinctly feebly arched; the hind sulcus hardly discernible, almost straight; fore margin of the disc indistinctly concave; its hind margin feebly sinuate in the middle; median keel obsolete; lateral keels between the front margin and the first sulcus very obtuse, convergent backwards and somewhat deflexed forwards; further backwards they are very distinct, shining. Lateral lobes of pronotum only about half again as long as their maximal height; their fore margin straight; the fore angle obtuse and rounded; the lower margin short, strongly ascendent, straight in its fore half and subconvex in the rest, forming a widely rounded, almost right angle with the hind margin, which has but a very feeble humeral sinus. Elytra with only their base concealed by the pronotum, inflated, covering more than three basal tergites. Abdomen without any carinae; hind margins of its tergites simply truncate; the last tergite rounded behind, with a deep, almost parallel-sided emargination in the middle, and faintly sinuate sides. Cerci thick, conical, somewhat incurved, with a thick, curved tooth about the middle. Subgenital plate moderately narrow; its hind margin very shallowly and obtusely excised; styli distinctly longer than the apical width of the plate. Prosternum armed with two short, acute spines. Front and middle femora with two small, depressed spines on the front lower margin, in the apical half. Hind femora with 3–4 outer and 5 inner spines below.

General coloration brown. Antennae reddish-brown, with narrow pale rings. The following parts are shining black: the inner surface of two basal antennal joints; fastigium of the front; fastigium of vertex on its front surface, on the sides of the upper surface, and the whole of its side surfaces, whence the black colour extends to the eyes, encircles the latter and forms a postocular fascia; lateral lobes of the pronotum (where the black merges into deep chocolate-brown in the middle portion), except a broad pale fascia along the lower margin, extending a little above the humeral sinus; upper

portion of pleurae and indefinite spots on the front and middle legs. Elytra reddish-brown, with a black fascia in the submarginal field and blackish veins of the speculum. Hind femora coarsely punctured, more densely so on their upper surface; the upper half pale, indefinitely marmorated with grey and brown, with a black spot at the base; the lower half separated from the upper one by a black line, with blackish-brown, indefinite striation. Abdomen dark reddish-brown, with the hind margins of tergites paler.

♀ (*paratype*). Subgenital plate distinctly transverse, V-emarginate in the middle, the lobes very broadly rounded. Ovipositor subequal in length to the hind femora, almost straight in the basal half, very distinctly recurved in the rest.

Length of body ♂ 25, ♀ 28; pronotum ♂ 8·5, ♀ 9; greatest width of pronotum ♂ 5·5, ♀ 5·5; projecting part of elytra ♂ 6, ♀ 0·5; hind femur ♂ 23, ♀ 22·5; ovipositor 20 mm.

Described from 5♂♂ and 5♀♀, all from Taipaishan, Shense Prov., China, 26 vii–13 x. 1905.

The species differs from all known ones by the distinctly upcurved ovipositor of the female, while in the shape of the male cerci it should be close to *A. brunneri*, from which it differs in the male sex, however, by the deeply excised last tergite and very shallowly emarginate subgenital plate.

3. **Atlanticus palpalis** Rehn and Heb. (Plate XXVIII, fig. 13.)

1920. *Atlanticus palpalis* Rehn and Hebard, Trans. Americ. Ent. Soc., xlvi, pp. 220–223, figs. 1–4.

It is very fortunate that the British Museum collection should happen to include a single male of this interesting species, described from the female sex only. The male agrees in all its characters with the original description, apart from the development of the elytra, which are as long as the pronotum and extend beyond the middle of the abdomen; the external genital parts are as follows:—

Last tergite transverse, with the middle portion distinctly projecting, deeply and narrowly incised in the middle, with the lobes triangular; cerci robust, semicircularly incurved, compressed dorso-ventrally, with a short, strongly curved postmedian tooth; the portion of the cerci beyond the tooth is much narrower than the basal portion; the apex attenuated in a sharp short tooth. Subgenital plate much deformed (the specimen has been preserved

in some liquid), but appears to be very narrowly and very deeply excised behind.

Length of body (contracted) 30; pronotum 12; exposed portion of elytra 13·5; hind femur 31 mm.

The species has been described from Yen-Ping, Fukien Province, China, and the male studied by me is practically a topotype, originating from Kualun, N.-W. Fukien.

It appears, that all three Asiatic representatives of the genus possess more developed elytra than the American ones, as well as more or less distinctly incurved male cerci; those characters are, however, not sufficiently important to justify a generic division. I am fully convinced that further investigations of the fauna of Eastern Asia will bring more species of this interesting genus.

Hemictenodecticus Caud.

1908. *Hemictenodecticus* Caudell, Gen. Ins., Fasc. 72, p. 28.

This is one of the imperfectly understood genera of *Decticinae*, as it has been founded by Caudell obviously without a study of the type species, *Ctenodecticus bolivari* Targ. Tozz., of which only the female has ever been described, Finot's description of both sexes being referable to a distinct species (see below). The principal point of difference between *Ctenodecticus* and *Hemictenodecticus* is supposed to be the number of the spurs of hind tibiae, which should be two in the former and four in the latter genus. I have found, however, in *Ct. pupulus*, which is a genotype of *Ctenodecticus*, that the inner pair of spurs is present, though the spurs are very minute and hardly discernible when examining the insect under a hand-lens, not under a binocular; I presume that this was the cause of Bolivar's misstatement that the species has not got the inner spurs. If I am right in my conclusion, the genera *Ctenodecticus* and *Hemictenodecticus* should be united, but I abstain from actually doing it because the material of the species of those genera studied by me has been very limited.

1. **Hemictenodecticus costulatus** (Costa). (Plate XXVIII, figs. 14, 15.)

1883. *Ctenodecticus costulatus* Costa, Atti Acad. Scien. Napoli, (2), i, 2, p. 87.

1908. *Hemictenodecticus costulatus* Caudell, Gen. Ins., Fasc. 72, p. 28.

Burr's collection contains a large series of this species from Asuni, Sardinia, and I take the opportunity to figure the male genitalia. *Ctenodecticus vasariensis* Finot (Bull. Soc. Ent. Fr., 1893, p. 251) from Algeria, which has been included by Caudell in *Ctenodecticus* in spite of Finot's definite statement that it has four tibial spurs, is suspiciously near *H. costulatus*, as far as it may be judged by description, and I should not be surprised if both species are identical.

2. **Hemictenódecticus algericus**, sp. n. (Plate XXVIII, figs. 16, 17.)

1896. ||*Ctenodecticus bolivari* Finot, Ann. Soc. Ent. France, lxv, p. 524 (*nec* Targioni-Tozzetti !)

The insect redescribed by Finot from Algeria under the name of *C. bolivari* cannot possibly be the latter species known from Sardinia, as it differs from it vastly in the general coloration, which is green in *C. bolivari*, according to its original description, and pale yellowish or greyish in the Algerian species; further difference may be seen in the shape of the hind margin of the lateral pronotal lobes, which should be without a humeral sinus in the female of *C. bolivari*, while the Algerian specimens show a distinct sinus. It may be expected that further differences exist between the males of both species, but the male of *C. bolivari* is unfortunately unknown. Nevertheless, I feel quite justified in proposing a new specific name for the insect described by Finot. The species is known to me from Mascara, Algeria, 1♂ (*Dr. Cros*, British Museum, *type*), and from Oran, 1♂, 2♀♀ (Oxford Museum, *paratypes*).

GAMPSOCLEIS Fieb.

Caudell has listed as many as twelve species of this genus, but two more have been described since by Shugurow (*podolica* and *annae*), seven by Adelung (*sowinskyi*, *caudata*, *kraussi*, *chritiniči*, *ussuriensis* and *schelkovnikovae*), one by Caudell (*Drymadusa mokanshanensis*), and two by Pylnov (*orientalis* and *amurensis*), which raises the number of species to twenty-six, with two additional sub-species *kraussi baicalensis*, Adelung and *abbreviata ebneri* Uvarov.

The great majority of species have been based, however, on single, or very few, specimens, and none of the authors, save one, paid any attention to reliability of characters used as specific ones. Adelung was the only student of the genus who attempted to appreciate the comparative value of certain characters, but it must be admitted that in his own study he uses for separating species just the very characters which he himself, in the preface, stated to be quite unreliable. As, moreover, practically all species have been described by authors who did not know the types of those described previously, it is practically impossible to see differences from descriptions. Shugurow made, nevertheless, an attempt to give a revision of the genus,* but it is a most superficial and useless piece of work, even as far as the ten species included in the "revision" are concerned.

As regards my own studies of the genus, I cannot regard them as anything more than preliminary ones, as I have had only a very limited material at my disposal, which did not permit me to appreciate definitely the range of variation of certain characters. As I had, however, an opportunity to study a considerable proportion of types of known species, I think it useful to give here a complete list of species of the genus, with the synonymy and notes on characters not mentioned or insufficiently described by previous authors, so that this work may serve as a basis for future revision of the genus.

Before proceeding with the list, I would like to discuss briefly the value of certain characters used by previous writers to separate species of *Gampsocleis*. Shugurow, in his revision, followed Brunner von Wattenwyl in regarding the absence and presence, as well as the number, of spinules on the underside of the femora as one of the most important taxonomic characters, but Adelung has shown that variations in this respect are very extensive, which makes this character most unreliable; this, however, did not prevent him from using it largely in his own paper. Much importance has been attached also to the relative dimensions of pronotum, elytra, hind femora and ovipositor, but a study of a few species represented by sufficiently long series shows most clearly—as it should be expected—that the taxonomic value of these characters is very doubt-

* Synopsis praecursoria specierum Eurasiaticarum generis *Gampsocleis* Fieb.-Zap. Novoross. Ob. Est. (Mem. Soc. Nat.), Odessa, xxxi, 1907, pp. 183–195.

ful; it seems that they may be used rather for the separating of geographical forms (it applies especially to the length of elytra) than of species, apart from the relative length of ovipositor, which may be to a certain extent used as a specific character. As regards the external genitalia, much attention has been paid to the shape of the female sub-genital plate, but my experience is that no importance whatever may be attributed to it, since this structure in *Gampsocleis* is but feebly chitinised, and therefore its shape and sculpture are in a great majority of cases unnatural, being more or less distorted by drying. Exactly the same applies to the shape of the male subgenital plate, as has been already stated by Adelung. Much more reliable characters may be found in the shape of the male cerci, though on the whole it is very uniform throughout the genus, and only minor variations of the same general type are peculiar to different species; indeed, so small are these variations that they can hardly be adequately described in words, and exact figures are a *conditio sine qua non* for identification of species. Unfortunately, no figures exist of male cerci of any previously described species, and I have done my best to fill this gap as regards species which I have been able to study. General coloration and pattern, especially of the elytra, supply some specific characters, but their value must not be overestimated, as individual variability in this respect is fairly considerable.

1. **Gampsocleis glabra** (Herbst). (Plate XXVIII, fig. 18.)

1786. *Locusta glabra* Herbst, Fuessly, Arch. Ins., viii, p. 193.
1870. *D[ecticus] gratiosus* Millet, Faune Invert. Maine-et-Loire, i, p. 307.
1899. *G[ampsocleis] glabra* var. *Assoi* I. Bolivar, Ann. Sci. Nat. Porto, vi, p. 13.
1907. *G[ampsocleis] podolica* Shugurow, Zap. Novoross. Ob. Est., xxxi, pp. 184, 185, 186.
1907. *G[ampsocleis] annae* Shugurow, *l.c.*, pp. 184, 185, 186.

I do not give the complete synonymy of the species, as it may be found in Kirby's catalogue (ii, p. 184), but merely a list of synonyms omitted by Kirby. Of *G. annae* and *G. podolica* I have studied topotypes and the type, respectively, and found their supposed specific characters of no

value (see my notes in Mitt. Kaukas. Mus., ix, 1915, p. 316, and *l.c.*, xi, 1917, p. 87). *G. assoi* Bol. is not distinct from *G. glabra* specifically, as Kirby suggested, but represents a fairly well-defined subspecies, restricted to Spain. As for *G. gratiosa* Millet, it is also unquestionably conspecific with *glabra*, and hardly separable from it as a subspecies; to settle this latter point, a study of large series of specimens from France would be necessary.

2. **Gampsocleis sedakovii** (F.W.). (Text-figs. C and D.)

1846. *Decticus Sedakovii* Fischer Waldheim, Orth. Imp. Ross., p. 161, pl. xxviii, figs. 3, 4.
1899. *Gampsocleis tamerlana* Burr, Ent. Rec., xi, p. 297.
1901. *Gampsocleis spinulosa* Krauss, Zoolog. Anz., xxiv, p. 239.
1909. *G[ampsocleis] sowinskyi* Adelung, Ann. Mus. Zool. St. Petersb, xiv, p. 336.
1909. *G[ampsocleis] kraussi* Adelung, *l.c.*, p. 339.
1909. *G[ampsocleis] kraussi baicalensis* Adelung, *l.c.*, p. 341.

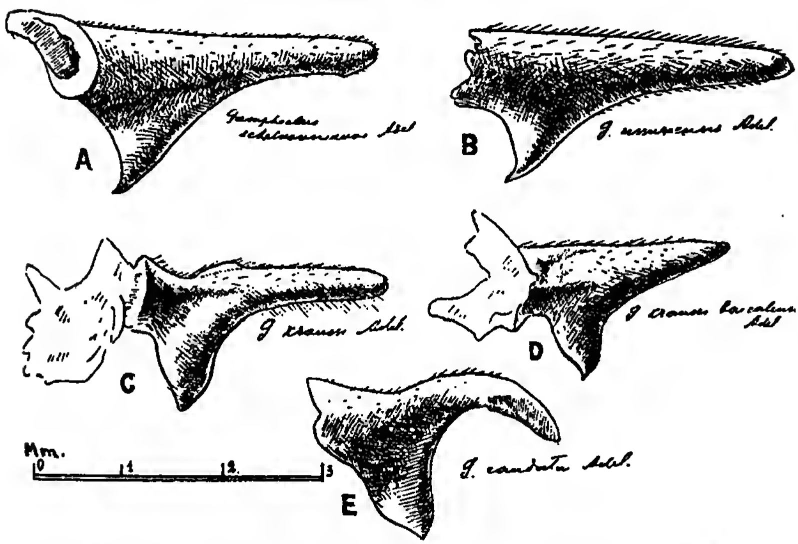
I have studied the types of *G. tamerlana* and *G. spinulosa* and they are undoubtedly conspecific. Of *G. kraussi* and sbsp. *baicalensis*, I possess the drawings of male cerci of the types,* and the difference between them, although considerable, does not exceed the usual range of variability observed in this species; moreover, the difference may be due simply to different state of preservation of cerci which often shrink considerably, and to the different angle of vision. *G. sowinskyi* Ad. has been described after a single female, and its differences from the description of *G. kraussi* and particularly from sbsp. *baicalensis* are negligible. I do not hesitate to identify all the above-mentioned species with *Decticus sedakovii*, as the figures and description of the latter exactly fit specimens before me, and the original locality (Verkhne-Oudinsk, prov. Irkutsk) agrees well with the general distribution of the species.

It is quite possible and almost certain that the species may be subdivided into several geographical races, differing from each other mainly in dimensions and proportions of

* I am greatly obliged to my friend Mr. B. Vinogradov, who kindly made for me drawings of male cerci of all the species described by Adelung, and to Miss E. Miram, who made the necessary preparations.

different parts, and some of the races may prove to coincide with certain of the above-named species; it would be, however, hardly justifiable to attempt a subspecific division now, when only odd specimens are known from a few localities scattered over the enormously vast area of distribution of the species.

Specimens examined: Hochsteppe im Gebiet des oberen Hoang-ho, 3450 m., 1♂, 1♀ (types of *G. spinulosa* Kr.; Dr. Krauss' collection); Mongolia, Urga, 1♂, 1♀ (types of *G. tamerlana* Burr; Oxford Museum); Verkhne-Oudinsk,



Male cerci of *Gampsocleis*—species described by Adelung. × 13·5.

Transbaicalia, 1♂ (topotype of *D. sedakovii* F. W.; Vienna Museum); E. Mongolia, 1♂ (British Museum); Sretensk, Shilka, 1♂ (Vienna Museum); Amur, 1♂ (Vienna Museum); Ussuri, 1♂ (Vienna Museum); Baranovsky, Amur, 1♂ (Vienna Museum); Tschenting, China, 1♀ (Vienna Museum); Tschili, China, 1♂ (Vienna Museum); Hongkong, 2♂♂, 1♀ (Vienna Museum).

The area of distribution of this species extends, thus, from the extreme east of European Russia (Perm; Adelung, *l.c.*, p. 343) right across the whole of Siberia to the Amur, while Mongolian and Chinese localities constitute some of the most southern known records.

3. **Gampsocleis caudata** Ad. (Text-fig. E.)

1909. *G[ampsocleis] caudata* Adelung, Ann. Mus. Zool. St. Petersb., xiv., p. 338.

The relatively very long ovipositor of the female, and strongly incurved male cerci make this species quite distinct from the preceding one, as far as one can judge by the description. The drawing of the male cercus of the type suggests, however, that the incurved apical portion is somewhat shrunk, and this may account for its unusual shape. The shape of the tooth on the cercus is very similar to that in *G. sedakovii*. The species has been described from an uncertain locality in the province of Yakutsk (see Adelung, Bull. Mus. Caucase, x, p. 319, footnote, where the author explains that the originally quoted locality " Okhonon " must be incorrect and probably refers to Ongoktom on the river Olenek).

4. **Gampsocleis buergeri** (De Haan). (Plate XXVIII, fig. 19.)

1842. *D[ecticus] buergeri* De Haan, Bijdr. tot de Kenn. Orth., p. 214.

1899. *Gampsocleis mutsohito* Burr, The Entom. Rec., xi, p. 297.

1899. *Gampsocleis mikado* Burr, *l.c.*, p. 296.

There can be very little doubt as to the identity of *D. buergeri* De Haan, meagre though its description is. A careful comparison of types of the two species by Burr did not enable me to detect any difference between them apart from that caused by the different state of preservation of the female subgenital plate. The species is closely allied to *G. sedakovii*, differing from it in the shape of the male cerci, and in the distinctly longer ovipositor.

The majority of specimens studied by me (mainly from the Vienna Museum) are labelled simply " Japan," and the only exact locality is Nagasaki.

5. **Gampsocleis obscura** (Walk.) (Plate XXVIII, fig. 20.)

1869. *Decticus obscurus* Walker, Cat. Derm. Salt. B.M. ii, p. 261.

1906. *G[ampsocleis] obscurus* Kirby, Syn. Cat. Orth., ii, p. 185 (*syn. excl.*).

1908. *G[ampsocleis] obscurus* Caudell, Gen. Ins., Fasc. 72, p. 11 (*syn. excl.*).
1909. *Gampsocleis christiniči* Adelung, Ann. Mus. Zool. Ac. St. Petersb., xiv, p. 343.

Although the types of *D. obscurus* Walk. are in a very bad state of preservation, the differences of the species from *G. gratiosa* Br. W. are so obvious that Kirby's mistake in regarding the latter as a synonym of *obscura* is inexcusable. Caudell naturally followed Kirby without being able to study the types himself. This is one of the largest species of the genus, remarkable for its brownish coloration, with the elytra bearing two very distinct broad, pale longitudinal fasciae. The male cerci are very like those of *G. sedakovii*; the ovipositor in profile is broader than in other species, with its upper margin almost straight, while the lower margin is distinctly concave, so that the narrowest part of the ovipositor is near its middle, and the ovipositor is somewhat widened towards the apex, which is obliquely truncate.

Apart from the Walkerian types which are from Corea, I have seen some specimens from the Vienna Museum, as follows:

Tschifu, China, 1871, 2♀♀; Kupekau, China, 1♂; Baranovsky, Amur, 1♂, 1♀.

The specimens from the Amurland differ from the Corean and the Chinese ones in the relatively longer elytra, and the ovipositor of the female is slightly more slender. Here is a table of measurements:

	Corea (types).		Tchifu.	Amur.	
	♂	♀	♀	♂	♀
Length of body ...	36 mm.	30 mm.*	34 mm.	33 mm.	33 mm.
,, ,, pronotum	11·5	10·5	11	11	10
,, ,, elytra ...	25	25	24	40	39
,, ,, hind femur	31	32	32·5	29·5	30·5
,, ,, ovipositor	—	23	22	—	20

* Abdomen contracted.

6. **Gampsocleis sinensis** (Walk.).

1869. *Decticus sinensis* Walker, Cat. Derm. Salt. B.M., ii, p. 261.

?1921. *Drymadusa mokanshanensis* Caudell, Proc. Ent. Soc. Washington, xxiii, p. 34.

With this species begins the second section of the genus comprising several closely allied species differing from the others by their relatively slender build, narrow and often very long elytra, and the practically uniformly green coloration without, or with but few indistinct dark markings; this combination of characters gives the insects a strong superficial resemblance to the members of the genus *Tettigonia*, from which they differ, of course, in the well-developed free plantulae of the hind tarsi.

Caudell's description of *Drymadusa mokanshanensis* leaves no doubt that he had before him a *Gampsocleis* of this group, and, as I fail to find any difference between his description and the type of *Decticus sinensis* Walk., I feel inclined to adopt the above synonymy, although I cannot insist on its being unquestionable, since the Walkerian type is a female, and no male exactly corresponding to it is known to me. Dr. Caudell kindly supplied me with a rough sketch of the male cercus and the subgenital plate of his species, and it appears that the species may be readily recognised by its very long cerci; the male styli are also much longer than in other species known to me in that sex. The ovipositor in the type of *sinensis* is relatively short and broad, obliquely truncate apically.

The measurements of the type are as follows: length of body 36; pronotum 9·8; hind femur 36·5; elytra 48; ovipositor 21·5 mm. When compared with the measurements given by Caudell, we find that the elytra of *sinensis* are some 6 mm. longer and the ovipositor 1·5 mm. shorter than in *mokanshanensis*, which does not exceed the usual range of variations in any species of the genus, and indeed in *mokanshanensis* the male type has the elytra 47 mm. long.

The type of *D. sinensis* is from Amoy, China; Caudell described his species from Mokanshan, China; a female exactly like the type of *sinensis* has been recently received by the Imperial Bureau of Entomology from the Bombay Natural History Society, labelled "Singapore, 20th Sept. 1913, F. H. Stone," but this record seems to require corroboration.

7. **Gampsocleis ussuriensis** Ad. (Text-fig. B.)

1910. *Gampsocleis ussuriensis* Adelung, Horae Soc. Ent. Ross., xxxix, p. 351.
?1918. *Gampsocleis amurensis* Pylnov, Mem. Inst. Agron. Voronezh, iii, p. 141.
1918. *Gampsocleis orientalis* Pylnov, *l.c.*, p. 142.

No doubt whatever may arise as to *G. orientalis* being an absolute synonym of *G. ussuriensis* Ad. As for *G. amurensis* Pylnov, it differs from *G. orientalis* only in a slightly smaller general size and relatively longer elytra; as the types of both species have been taken at the same place and date, it seems very unlikely that they are not conspecific though so very closely allied.

The species is nearer to the members of the first group than any other of the second group, as the elytra are sometimes fairly conspicuously spotted in the postradial field; sometimes, however, they are uniformly green, with only the radial veins brown.

The species is known to me from the following localities: River Mangugai, S. Ussuri-land (Adelung, *l.c.*; type of *G. ussuriensis*); Khabarovsk, prov. Primorskaya (Pylnov, *l.c.*; types of *G. amurensis* and *G. orientalis*); Amur, 1 ♀ (Vienna Museum); Tchifu, China, 2 ♂♂, 1 ♀ (Vienna Museum); China, 1 ♂ (Vienna Museum).

There is in the Vienna collection one female from Nagasaki, Japan, which may belong to this species as well, but it differs by the elytra scarcely surpassing the abdomen, and the relatively long ovipositor, so that I hesitate to identify it with *ussuriensis*.

8. **Gampsocleis shelkovnikovae** Ad. (Text-fig. A.)

1916. *Gampsocleis shelkovnikovae* Adelung, Bull. Mus. Caucase, x, p. 313,* fig. 1*a*.

This is a species extremely similar in all respects to *G. ussuriensis*; the male cerci in both species hardly differing, but the ovipositor in *G. shelkovnikovae* is quite three times

* This paper by Adelung has not been included in the Zoological Record; it is entitled "Description d'une nouvelle espèce du genre *Gampsocleis* avec un aperçu des espèces russes de ce genre," and contains, apart from the description of *G. schelkovnikovae*, a list of Russian species, with remarks on their distribution.

as long as the pronotum, while in *ussuriensis* it is only about two and a half times as long as pronotum; the male subgenital plate in *G. schelkovnikovae* has a narrow and deep acutangular emargination in the middle only, while in *G. ussuriensis* the emargination is broader, more shallow, and occupies the whole hind margin of the plate. Elytra of *G. shelkovnikovae* vary in length considerably, while in the coloration they may be either uniformly green (or greenish-yellow) or with the anal field brownish, but without any spots, which makes the resemblance to a *Tettigonia* perfect.

G. schelkovnikovae has been discovered by Dr. Malcolm Burr in Geok-Tapa, Transcaucasia, and it is known to me from a number of localities in the eastern and southern parts of that country, as well as from the northern Caucasus (River Kuma; Kislovodsk). It is an extremely interesting zoogeographical fact that a species so very closely related to the eastern-Asiatic members of the group should be found so far west and south.

9. **Gampsocleis gratiosa** Br. W. (Plate XXVIII, fig. 21.)

1862. *Gampsocleis gratiosa* Brunner v. Wattenwyl, Voch. z.-b. Ges. Wien, xii, p. 94.

1888. *Gampsocleis gratiosa* Pictet, Mém. Soc. Phys. Hist. Nat. Génève, xxx (6), p. 57, pl. iii, fig. 34.

1899. *Drymadusa fletcheri* Burr, The Entom Rec., xi, p. 298.

The name given to this splendid species by Brunner must stand, as Kirby in his catalogue (ii, p. 185) made one mistake in regarding it as a synonym of *D. obscurus* Walk. (see above), and another one in quoting *G. gratiosa* of Millet as described in 1828 (which would make the name praeoccupied in the genus), while Millet's description has been published only in 1870.* *Drymadusa fletcheri* of Burr is obviously a female of this species, as I may state after a study of the type, and Burr's statement as to the free plantulae being very short, which would make it possible to include the species in *Drymadusa*, is in disagreement with the type.

The third group of the genus begins with this species; it includes species with strongly abbreviated elytra; the males are especially remarkable for their elytra being

* The date 1828 applies to the first volume of the "Faune de Maine-et-Loire," which contains vertebrates only.

inflated and broadly rounded behind, while the females are of the same type as in the next group.

The specimens of *G. gratiosa* studied by me were from the following localities: Shanghai, Novara Reise, 1 ♂ (Brunner's type; Vienna Museum); Tschifu, 1 ♂, 1 ♀ (Vienna Museum); Wei-hai-wei, 1 ♀ (type of *D. fletcheri* Burr; Oxford Museum); Chefoo, 1 ♀ (Brit. Museum); Taipaishan, Shense prov., 20 vii, 1905, 13 ♂♂ (Brit. Museum).

Three males in the British Museum from Northern China differ from all the others seen by me by their much smaller size, dark brown coloration, with the pronotum partly even blackened, the elytra more inflated and very broad at the apex. I regard them as a distinct subspecies with the name INFUSCATA, subsp. nov.; they are all from Chih Feng, N. Chihli Prov., N. China (*A. L. Hall*), and the measurements of the type are as follows: Length of body 35; pronotum 10; elytra 16; hind femur 26 mm.

10. **Gampsocleis inflata**, sp. n. (Plate XXVIII, fig. 22.)

♂. Related to *G. gratiosa* Br. W., but much smaller. Coloration uniformly greenish-yellow (probably pale green in life). Disc of the pronotum smooth, distinctly widened in the metazona, which is somewhat raised and convex, regularly rounded behind; lateral lobes forming distinct rounded angles with the disc posteriorly, and marked with castaneous along those edges. Elytra strongly inflated, practically enveloping the whole abdomen, strongly widened and broadly rounded posteriorly, uniformly pale-green. Front femora with 4 small blackish spines below, on the front margin; middle femora with 5 spines on the anterior lower carina; hind femora with a few very small and irregularly placed spinules on both lower carinae. Cerci extending beyond the subgenital plate, practically straight, cylindrical, with a conical tooth placed distinctly beyond the middle; the apical portion of the cerci conical. Subgenital plate with broad rectangular emargination; styli short and thick.

Length of body 26; pronotum 9·5; elytra 18; hind femur 24 mm.

The type is from Shantung, N. China (*Prof. R. Ebner's collection in Vienna*); two male paratypes in the British Museum are labelled "Hai-Ring, J. J. Walker."

The species is very easily recognisable by the abnormally inflated elytra and by the postmedian position of the cercal

tooth. The paratypes in the British Museum are in poor condition, having been preserved in alcohol and lost their colour, but not the slightest doubt may exist as to their being not conspecific with the type.

11. **Gampsocleis recticauda** Werner.

1901. *Gampsocleis recticauda*, Werner, Sitzungsber. Akad. Wiss. Wien, Mat.-nat. Cl., cx, Abt. i, p. 292, pl. ii, fig. 7.

Both Kirby and Caudell incorrectly quoted this species as described by Jacobson. This species, together with the next one, form the fourth group in the genus, characterised by the strongly abbreviated elytra of both sexes; the group is restricted geographically to Asia Minor and the Balkan peninsula.

12. **Gampsocleis abbreviata** Herm. (Plate XXVIII, fig. 23.)

1874. *Gampsocleis abbreviata* Herman, Verh. z.-b. Ges. Wien, xxiv, pp. 197, 201.

The typical form occurs in Dalmatia, while a very distinct southern race has been described by me recently from Macedonia under the name sbsp. *ebneri* Uvar. (The Entom. Rec., xxxiii, 1921, p. 159).

DECTICUS Serv.

1831. *Decticus* Serville, Ann. Scien. Natur., xxii, p. 155.
1838. *Chelidoptera* Wesmael, Bull. Acad. Scien. Bruxelles, v, p. 591.
1839. *Decticus* Westwood, Intr. Mod. Class. Ins., ii, Syn., p. 45.
1906. *Tettigonia* Kirby, Syn. Cat. Orth., ii, p. 212.
1908. *Tettigonia* Caudell, Gen. Ins., Fasc. 72, p. 23.

The much-entangled question as to which species of the Linnean genus *Gryllus Tettigonia* should be considered its genotype is discussed by me above, under the genus *Tettigonia*; and my conclusion being that it is *viridissima* and not *verrucivora*, the next available generic name, viz. *Decticus* Serv., must be used in connection with *verrucivora*. The genus *Chelidoptera* of Wesmael is a pure synonym of *Decticus* Serv., and there is no doubt that *verrucivora* is

the type of the genus, as formally fixed by Westwood in 1839 (*l.c.*).

Caudell (*l.c.*), following Kirby (*l.c.*) counts as many as seven species of this genus, but one of them (*assimilis* Fieb.) has been recently removed by me into the genus *Medecticus*; both species of Fischer-Waldheim, *macrocephalus* and *stchukini*, are undoubtedly conspecific with *verrucivorus*; *D. fuscescens* of Blanchard from Chile has obviously nothing to do with this purely Palearctic genus; and the generic position of *D. japonicus* Bol. has not been clear even to its author, so that it may be retained in the genus only with a query. Thus, only *verrucivorus* and *albifrons* F. unquestionably belong to the genus *Decticus*; both are well-known insects and I shall not dwell on them.

PHOLIDOPTERA Werm.

The synonymy of this genus has been given by Caudell, and I shall not repeat it here. His list comprises twenty-three species, but Ebner has recently shown * that *P. indistincta* Bol. is probably conspecific with *P. signata* Br. W., while, on the other hand, as many as ten new species have been described since, and I think it useful to give an additional list.

1907. *P. ornata* (*Olynthoscelis*) Nedjelkov, Period. Spis. Bolgarsk. Knizhn. Druzh. Sofia, lviii, p. 432 (Bulgaria).
1908. *P. karnyi* Ebner, Verh. z.-b. Ges. Wien, p. 334, pl. ii, figs. 9, 10, 11 (Dalmatia).
1911. *P. heptapotamica* (*Olynthoscelis*) Pylnov, Revue Russe d'Entom., xi, p. 369 (E. Turkestan).
1912. *P. pietschmanni*, Ebner, Ann. Naturhist. Hof. Mus. Wien, xxvi, p. 447, fig. 3 (Mesopotamia).
1914. *P. festae* Giglio-Tos, Boll. Mus. Torino, xxxix, No. 680, p. 5 (Rhodos).
1916. *P. satunini* (*Olynthoscelis*) Uvarov, Bull. Mus. Caucase, x, p. 52 (Transcaucasia).
1916. *P. zebra* (*Olynthoscelis*) Uvarov, *l.c.*, p. 190, figs. 6, 7, 8 (Kurdistan).
1916. *P. kurda* (*Olynthoscelis*) Uvarov, *l.c.*, p. 192, fig. 9 (Kurdistan).
1917. *P. kerketa* (*Olynthoscelis*) Uvarov, *l.c.*, xi, p. 296, figs. 14, 15 (Caucase).

* Arch. für Naturgesch., 1919, A, 8, p. 157.

1921. *P. distincta* (*Olynthoscelis*) Uvarov, Ent. Monthly Mag., 3rd ser., vii, p. 49 (Transcaucasia).

One more species, *P. persica*, has been described in 1921 by Chopard, but it does not belong here and is included provisionally in *Paradrymadusa* (see p. 498). Thus, the number of species known up to date is thirty-two.

Metrioptera Wesm.

1838. *Metrioptera* Wesmael, Bull. Acad. Bruxelles, v, p. 592.

1852. *Platycleis* Fieber, Kelch, Grundl. Orth. Oberschles., p. 2.

1906. *Chelidoptera* Kirby, Syn. Cat. Orth., ii, p. 203.

Wesmael subdivided the genus *Decticus* of Serville into three subgenera : *Chelidoptera*, *Metrioptera* and *Pholidoptera*, one of which must be considered as a pure synonym of *Decticus*, and this is undoubtedly *Chelidoptera*, as it includes *verrucivorus*, the genotype of *Decticus*. The type of *Metrioptera* is *brachyptera* L., this being the only species originally included in it, but the present conception of the genus is very broad and makes it somewhat heterogenous and not very natural; it must be expected that a thorough revision of the genus, which is badly wanted, may result in splitting it up into two or three genera, one of which may retain Fieber's name *Platycleis*, the genotype of the latter being *intermedia* Serv., as fixed by Herman (Verh. z-b. Ges. Wien., xxiv, 1874, p. 207).

It is a Mediterranean genus in its distribution, only a few species ranging all over Europe, one occurring in Japan and one described by Caudell from Canada. The number of species enumerated by Caudell in 1908 was forty-eight, but about twenty have been described since, and a good many more new ones may be expected from the Balkans, Asia Minor, Persia and Turkestan. Four new species are described below. Apart from the descriptions of new species, I will give just a few notes on synonymy of some species, particularly those described by Burr; while a list of species described since Caudell's catalogue may be also of use.

A list of species of Metrioptera described since 1907.

1907. *M. iphigeniae* (*Platycleis*) Adelung, Ann. Muz. Zool. St. Petersb., xii, p. 409 (Crimea).

1910. *M. dubia* (*Platycleis*) Uvarov, Horae Soc. Entom. Ross., xxxix, p. 384, figs. 6, 7 (S.E. Russia).
1911. *M. biedermanni* (*Platycleis*) Zoolog. Anz., xxxvii, p. 121 (Sardinia) = *M. intermedia*, see below.
1912. *M. squamiptera* (*Platycleis*) Uvarov, *l.c.*, xl, No. 3, p. 36, pl. i, fig. 6 (Transcaspia).
1912. *M. fatima* (*Platycleis*) Uvarov, *l.c.*, p. 37 (Transcaspia).
1912. *M. semenovi* (*Platycleis*) Uvarov, Revue Russe d'Entom., xii, p. 213 (Turkestan).
1912. *M. barretii* (*Platycleis*) Burr, The Entom. Record, xxiv, p. 31, pl. i, figs. 2–7 (Madeira).
1914. *M. plotnikovi* (*Platycleis*) Uvarov, *l.c.*, xiv, p. 227 (Turkestan).
1914. *M. sabulosa* sbsp. *indecisa* Bolivar, Mem. Soc. Esp. Hist. Nat., viii, 5, p. 232 (Tanger).
1914. *M. decticiformis* (*Platycleis*) Stschelkanovzeff, Mitt. Kaukas. Mus., vii, pp. 107, 120, fig. 2 (Caucasus).
1916. *M. tomini* (*Platycleis*) Pylnov, Revue Russe d'Entom., xvi, p. 280, figs. 1, 2 (Mongolia).
1917. *M. persica* (*Platycleis*) Uvarov, Bull. Mus. Caucase, xi, p. 291, fig. 9 (Teheran).
1917. *M. iljinskii* (*Platycleis*) Uvarov, *l.c.*, p. 293, fig. 10 (Transcaucasia).
1917. *M. daghestanica* (*Platycleis*) Uvarov, *l.c.*, p. 294, figs. 11, 12 (Daghestan).
1917. *M. capitata* (*Platycleis*) Uvarov, *l.c.*, p. 295, fig. 13 (N. Persia).
1920. *M. coracis* (*Platycleis*) Ramme, Arch. Naturg., 86, Heft 12, p. 125, figs. 3–8; pl. iii, figs. 3*a*, 3*b* (Greece).
1920. *M. falzfeini* (*Platycleis*) Ramme, *l.c.*, p. 131, figs. 14–17; pl. iii, figs. 4*a*, 4*b* (S. Russia).
1921. *M. burri* (*Platycleis*) Uvarov, Entom. Monthly Mag., 3rd ser., vii, p. 50 (Transcaucasia).
1922. *M. macedonica* Berland and Chopard, Bull. Mus. Hist. Nat., p. 234, fig. 8 (Macedonia).*

1. **Metrioptera truncata** (Wern.).

1901. *Platycleis truncata* Werner, Sitzungsber. Akad. Wiss. Wien, cx, p. 296, pl. i, fig. 3.

* Two more species, *M. minuta* and *M. carinata*, described in that paper are conspecific with *M. truncata* and *M. nigrosignata*, respectively (see under those species).

1903. *P[latycleis] truncata* Jacobson, Priamokr. Lozhn. Ross. Imp., p. 409.
1906. *C[helidoptera] truncata* Kirby, Syn. Cat. Orth., ii, p. 203.
1908. *M[etrioptera] truncata* Caudell, Gen. Ins., Fasc. 72, p. 32.
1922. *Metrioptera minuta* Berland and Chopard, Bull. Mus. Hist. Natur., p. 232, figs. 6, 7.

Both Kirby and Caudell overlooked the original description of this species, and give as a reference Jacobson's book, where nothing more than a translation of Werner's description is given; the reason for it probably is that Werner's paper has not been included in the Zoological Record.

2. **Metrioptera moldavica**, sp. n. (Plate XXVIII, figs. 24, 25.)

♂. Small and slender, chestnut-brown. Face with indefinite fuscous marmoration. Postocular pale fascia, surrounded by fuscous, indistinct. Disc of the pronotum feebly widened posteriorly, somewhat impressed in the middle, chestnut coloured; median carinula conspicuous in the metazona only; lateral lobes almost vertical, forming rounded angles with the disc, testaceous, blackened towards the hind margin, which is pale, while all other margins are unicolorous with the lobes. Elytra not quite reaching to the middle of the abdomen, with parabolic apices, brown, with 2–3 indefinite dark spots in the middle and the radial vein blackened. Hind femora long; the outer face black, with a pale fascia along the middle. Last tergite with a deep impression in the middle, very narrowly excised, the lobes closely approximate, about four times as long as at the base wide, conical, parallel with each other. Cerci about as long as the lobes of the last tergite, conical, apparently without a tooth (unless there is one at the very base which is not visible). Subgenital plate tectiform, carinated along the middle, obtuse-angulately emarginate behind; styli a little shorter than the hind margin of the plate is broad.

♀ (*paratype*). Lateral lobes of the pronotum marginated with pale throughout. Elytra extending to the fourth tergite, with the principal veins blackened. Subgenital plate transverse, feebly convex, with two lateral transverse concavities near the hind angles directed towards the middle; hind margin straight, truncate, with a very short median carinula in its middle. Ovipositor about twice as long as the pronotum, not strongly, but regularly recurved,

fuscous along the lower margin, blackened in the apical third of the upper margin.

Length of body: ♂ (type) 14, ♀ (paratype) 16·5; pronotum ♂ 4, ♀ 4·5; elytra ♂ 4·5, ♀ 5; hind femur ♂ 16, ♀ 17·5; ovipositor ♀ 11 mm.

Berlad valley, Moldavia, 1♂, 1 ♀ (*A. C. Montandon; Oxford Museum*).

Two specimens of this species have been found by me in Dr. Burr's collection, amongst a series of *M. vittata* taken at the same locality. The species is extremely well characterised by the external genitalia of both sexes, especially by the unusually long apical lobes of the last tergite in the male.

3. **Metrioptera nigrosignata** (Costa).

1863. *Decticus nigrosignatus* Costa, Atti Acad. Sci. Napoli, i (2), p. 30, pl. iii, figs. 3, 3*c*, 4.
1882. *Pl*[*atycleis*] *nigrosignata* Brunner, Prodr. Eur. Orth., p. 351.
1899. *Platycleis orina* Burr, The Entom. Rec., xi, p. 20.
1912. *Platycleis orina* = *P. nigrosignata* Karny, Wien. Entom. Zeit., xxxi, p. 292.
1922. *Metrioptera carinata* Berland and Chopard, Bull. Mus. Hist. Natur., p. 231, fig. 5.
1923. *Metrioptera nigrosignata* Uvarov, Trans. Ent. Soc. London, p. 153.

I have studied the actual types of *P. orina* Burr when establishing the above synonymy.

4. **Metrioptera brachyptera** (L.).

1761. *Gryllus brachypterus* Linnaeus, Fauna Suec. (2nd edit.), p. 237.
1899. *Platycleis raia* Burr, The Entom. Rec., xi, p. 19 (*partim*!).

The types of *P. raia* in Burr's collection are one male, one female and one female larva, which undoubtedly belong to *M. brachyptera*, while another male is *M. roeselii* Hag. It is obvious that in the original description the coloration and the shape of elytra have been described after the *brachyptera* specimens, while the male genitalia described are those of the male of *roeselii*, since the *brachyptera* male has the abdomen broken off; colour

differences of *raia* and *brachyptera* are due to Burr's types having been preserved in alcohol. There is no wonder that Karny could not recognise *P. raia* from Burr's description, and incorrectly referred the name to another equally badly described species by Burr, *P. prenjica* (see under that species).

5. **Metrioptera roeselii** (Hag.).

1822. *Locusta roesellii* Hagenbach, Symb. Faun. Ins. Helv., p. 39, fig. 2.
1899. *Platycleis raia* Burr, The Entom. Rec., xi, p. 19 (*partim* !).

See above, under *M. brachyptera*.

6. **Metrioptera prenjica** (Burr). (Plate XXVIII, fig. 26.)

1899. *Platycleis prenjica* Burr, The Entom. Rec., xi, p. 20.
1912. ‖ *Platycleis raia* Karny, Wien. Entom. Zeit., xxxi, p. 295 (*nec* Burr !).

The examination of the types of *P. prenjica* in Burr's collection, and their comparison with Karny's descriptions of his *prenjica* and *raia*, showed me at once that Karny has misidentified his specimens, which is easy to understand in view of unsatisfactory descriptions by Burr, and especially of the muddle he introduced into his description of *raia* (see above). Prof. Ebner kindly loaned me some specimens collected by himself and Karny, and examined by the latter when he wrote his paper; these proved to be, as I expccted, not *raia* as identified and re-described by Karny, but true *prenjica*. As for *prenjica* Karny (*nec* Burr !), the specimens sent me under that name by Prof. Ebner proved to belong to two different species, none of them agreeing with the types of *prenjica*; one of them I leave unnamed until more material may be studied, while another is described below as a new species.

7. **Metrioptera karnyana**, sp. n. (Plate XXVIII, fig. 27.)

1912. ‖ *Platycleis prenjica* Karny, Wien. Entom. Zeit., xxxi, p. 293 (*nec* Burr !).

♂. Small, slender, chestnut-brown. Face with some black dots, and a black spot at the lower anterior angle of each eye; occiput and vertex with a pale median line included between two irregular and largely interrupted blackish fasciae; above each eye there is a

broad black fascia including a pale line. Pronotum with the disc distinctly widened posteriorly, somewhat impressed; lateral keels bearing distinct scattered punctures; the V-shaped sulcus and two dots before it, black; lateral lobes black, spotted with brown in their upper parts, with a sharply defined pale border below and behind. Elytra reaching the fifth tergite, with broadly elliptic apices, uniformly brown. Abdomen with two interrupted black lateral fasciae, gradually obsolescent behind; hind margin of each tergite with a few black dots. Hind femora moderately long, relatively thick; upper half of their outer face chestnut, with some black transverse fasciae at the base; the lower half black with a few brown fasciae. Last tergite broadly impressed behind, with a broad, round emargination and short, rectangular lobes. Cerci just reaching to the apex of the subgenital plate, straight, slender though somewhat depressed and dilated in the portion before the tooth; the latter is placed at about two-thirds of the length of the cercus, it is slender, regularly recurved and somewhat decurved; the apical portion of the cerci quite slender. Subgenital plate truncate behind; styli distinctly shorter than the plate is broad behind.

♀ (*paratype*). Elytra greenish-brown, reaching the third tergite. Abdomen with a distinct median carinula. Subgenital plate broadly triangular, only a little longer than its basal width; the sides slightly convex; apex with a triangular emargination, about as deep as it is broad behind; the lobes with the apical angles about 60°, rounded; the surface of the plate convex. Ovipositor not strongly, but regularly recurved, seen in profile distinctly narrowed apically; black, with the base pale; longer than the abdomen.

Length of body ♂ 15, ♀ 18; pronotum ♂ 4, ♀ 5; elytra ♂ 5, ♀ 4; hind femur ♂ 16·5, ♀ 17·5; ovipositor ♀ 11·5 mm.

Described after a pair from Ruževača, Herzegovina, 15 viii. 1911 (*R. Ebner's collection*).

8. **Metrioptera ambitiosa**, sp. n. (Plate XXVIII, figs. 28, 29, 30.)

♂. Related to *M. roeselii*, but much larger. Head relatively large, straw-coloured; supraocular fascia broad, black, with a sharply defined pale median line; a castaneous median fascia along the vertex and occiput, with a pale line included. Disc of the pronotum parallel-sided, not narrowed anteriorly, very pale brownish, with the lateral margins pale; its surface flat, forming distinct, rounded angles with the lateral lobes, which are practically vertical, rounded-triangular, broadly marginated with pale straw colour

all round, with rich castaneous and black marmoration. Pleurae with black fasciae. Elytra reaching the last tergite, broad, but with the apex parabolic, pale brownish coloured, with the principal veins black, except the radial, which is ivory-white in the basal half and brown in the rest; the disposition of the veins as in *M. roeselii*; the marginal field is broadest in the apical quarter but narrowed at the apex. Last tergite large, transverse, not prominent behind, with moderately broad depression, the margins of which are carinated; hind emargination broad, very shallow; lobes very narrow, sharp, as long as the styli, deflexed; the distance between their bases half as long again as one of the lobes. Cerci longer than the subgenital plate, cylindrical, feebly incurved, with a very short and obtuse tooth in the apical fourth. Titillator feebly sinuate, with a few spinules before the apex which is decurved and pointed. Subgenital plate large, carinulated in the middle; hind emargination obtusangular, rounded, with the sides rounded. Styli much shorter than the distance between them. Hind femora unicolorous pale, reddish-brown.

Length of body 18; pronotum 6·5; elytra 10; hind femur 20 mm.

A single male has been taken by Dr. Malcolm Burr at Hortiack Plateau, Macedonia, 15–18 viii. 1918 (*type* in the British Museum).

This beautiful new species (which I at first mistook for *M. roeselii*; see Trans. Ent. Soc. London, 1923, p. 153) is easily distinguished from *M. roeselii* by the differently built last tergite, cerci and titillator, as well as by the shape of elytra, larger size and more variegated coloration. It seems to be closely related to *M. bispina* Bol. (described by Bolivar from Asia Minor as *M. roeselii* var. *bispina*, but obviously a good species), but differs from it, as far as it may be judged from Bolivar's short description, by the apically narrowed elytra, more broadly emarginated last tergite, shorter tooth of the cerci (subequal to the styli in *bispina* and much shorter than those in *ambitiosa*) and smaller size.

9. **Metrioptera pylnovi**, sp. n. (Plate XXVIII, fig. 3, 31, 32.)

♂. Resembling *M. roeselii*, but somewhat larger. General coloration brown. Face with scattered puncturation; subocular fasciae and median fascia of the head very broad, black, with sharply defined median pale lines. The median pale line runs on to the disc of the pronotum, which is pale brown and narrowed anteri-

orly; lateral lobes almost vertical, forming rounded angles with the disc, shining black, with sharply defined yellowish front, lower and hind margins. Pleurae yellowish, with black fasciae. Elytra reaching to the base of the last tergite, shaped and reticulated as in *M. roeselii*, but the apex narrowed, rotundato-angulate; their coloration uniformly brownish, with the principal veins black, except the radial vein, which is reddish-flavous. All legs reddish-brown; hind femora with a narrow blackish line along the middle of the outer area. Abdomen with a pale median line, included between two black ones. Last tergite transverse, feebly prominent behind; the median impression deep, oval, with the margins carinated; the hind emargination deep, parabolic; lobes narrow, pointed, decurved, a little shorter than styli. Cerci very like those of *M. roeselii*, but distinctly longer than the subgenital plate, cylindrical, scarcely incurved, with a strong, pointed tooth in the apical third. (Titillator has been studied on one of the paratypes; it is strongly decurved apically, and armed with three small spines before the apex.) Subgenital plate carinated along the middle; hind emargination rectangular, with the sides convex; styli about as long as the tooth of the cerci.

♀ (*paratype*). Elytra not reaching the middle of the abdomen. Subgenital plate flattened, carinated along the middle; the hind emargination deep, acute, its sides distinctly concave, the lobes in profile very narrow. Ovipositor as in *M. roeselii*.

Length of body ♂ (*type*) 19, ♀ (*paratype*) 23; pronotum ♂ 4·5, ♀ 5; elytra ♂ 9·5, ♀ 7·5; hind femur ♂ 16, ♀ 18; ovipositor ♀ 7 mm.

Described from 5 ♂♂ and 9 ♀♀ taken by Mr. E. König at Bakuriani, Caucasus, 5–10 ix. 1912 (*Oxford Museum*).

M. pylnovi has evidently been mistaken by all writers on the Orthoptera of the Caucasus, myself included, for *M. roeselii*, but its differences from the latter species are so numerous and important (genitalia, elytra) that there can be no doubt as to its being an independent species. As the occurrence of the true *M. roeselii* in the subalpine regions of the Caucasus (where *M. pylnovi* occurs) is, however, not impossible, a careful revision of materials from different localities is necessary before *M. roeselii* is excluded from the Caucasian fauna.

The new species seems to be related also to *M. bispina* Bol. from Asia Minor, but the latter is a much larger species with the elytra still more broad apically than in *M. roeselii*, while in *M. pylnovi* they are distinctly narrowed at the

apex; even if there are no other differences, which is not to be ascertained from Bolivar's meagre description, the Caucasian insect should be regarded as a well-defined geographical race of *M. bispina.*

The coloration of the new species is not more constant than it is in *M. roeselii* and in its other congeners, so that in some specimens the lateral lobes of the pronotum may be uniformly testaceous, not black and bordered with yellowish; the general coloration also varies in shade, but it is always more or less testaceous and never green, or even greenish.

The specific name is given to commemorate my prematurely deceased friend, the promising young orthopterist, E. V. Pylnov, who has done some very thorough work on the Orthoptera of various parts of Russia.

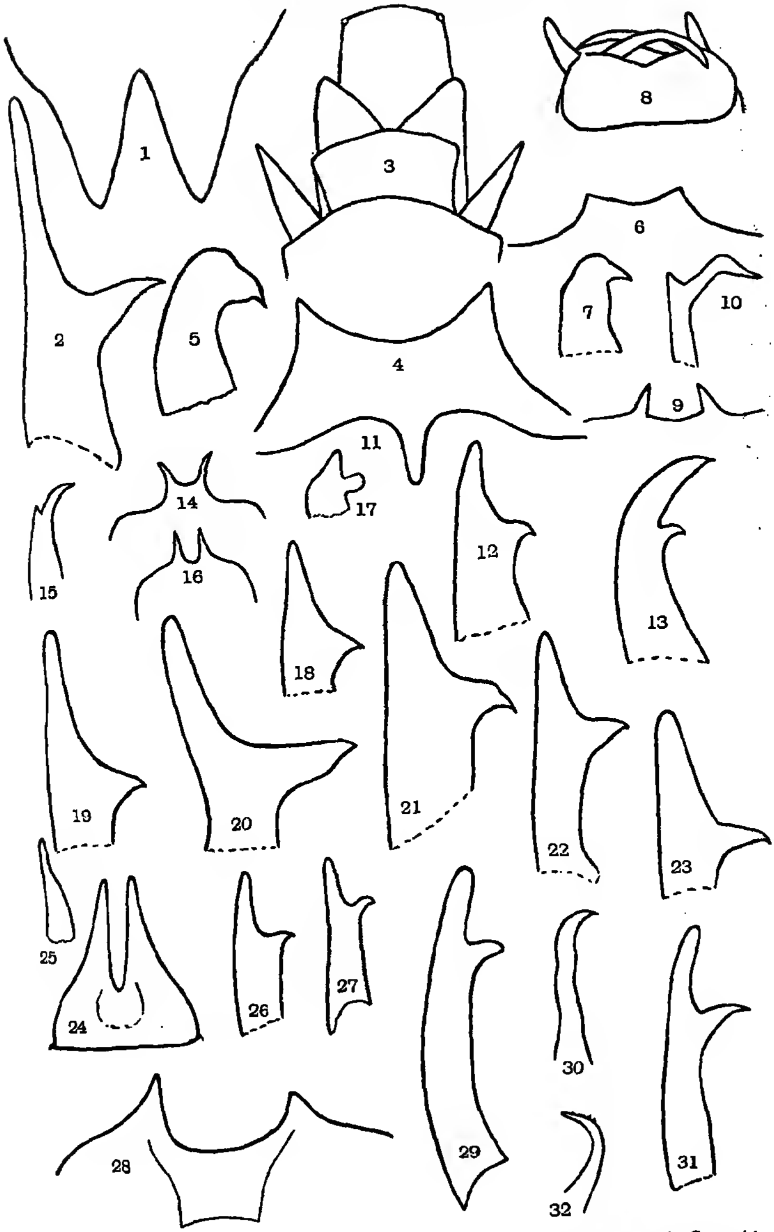
10. **Metrioptera intermedia** (Serv.).

1839. *Decticus intermedius* Serville, Ins. Orth., p. 488.
1911. *Platycleis biedermanni* Wolff, Zoolog. Anz., xxxvii, p. 121, figs. 1, 2*a*, 2*b*, 3.

Wolff's species is known to me by topotypes in Burr's collection, taken by Dr. Krausse at Asuni in Sardinia in 1910, that is, probably, together with the types, and there is no doubt that *biedermanni* is a pure synonym of *intermedia.*

Explanation of Plate XXVIII.

Fig. 1. *Tettigonia orientalis*, sp. n. Type; last tergite.
2. ,, ,, ,, ,, right cercus.
3. *Neduba carinata* Walk. Type; dorsal view of genital complex.
4. *Anarytropteris fallax*, gen. and sp. n. Type; last tergite.
5. ,, ,, ,, ,, ,, right cercus.
6. *Thoracistus viridifer* (Walk.). Type; last tergite.
7. ,, ,, ,, ,, right cercus.
8. *Dexerra turpis* Walk. Type; dorsal view of genital complex.
9. *Phlesirtes brachiatus*, sp. n. Type; last tergite.
10. ,, ,, ,, ,, right cercus.
11. *Atlanticus sinensis*, sp. n. Type; last tergite.
12. ,, ,, ,, ,, right cercus.



B.P.U. del. *Vaus & Crampton.*

MALE GENITALIA OF TETTIGONIINAE AND DECTICINAE.

13. *Atlanticus palpalis* Rehn and Heb. Right cercus.
14. *Hemictenodecticus costulatus* (Costa). Last tergite.
15. „ „ „ „ Right crecus.
16. *Hemictenodecticus algericus*, sp. n. Type; last tergite.
17. „ „ „ „ „ right crecus.
18. *Gampsocleis glabra* (Herbst). Right cercus.
19. *Gampsocleis buergeri* (De Haan). Right cercus of the type of conspecific *G. mikado* Burr.
20. *Gampsocleis obscura* (Walk.). Right cercus.
21. *Gampsocleis gratiosa* Br. W. Type; right cercus.
22. *Gampsocleis inflata*, sp. n. Type; right cercus.
23. *Gampsocleis abbreviata ebneri* Uvar. Paratype; right cercus.
24. *Metrioptera moldavica*, sp. n. Type; last tergite.
25. „ „ „ „ right cercus.
26. *Metrioptera prenjica* (Burr). Type; right cercus.
27. *Metrioptera karnyana*, sp. n. Type; right cercus.
28. *Metrioptera ambitiosa*, sp. n. Type; last tergite.
29. „ „ „ „ „ right cercus.
30. „ „ „ „ „ titillator.
31. *Metrioptera pylnovi*, sp. n. Typc; right cercus.
32. „ „ „ „ Paratype; titillator.

All figures drawn by the Zeiss camera-lucida, about eight times the natural size.

XXV. *Physical Factors Controlling Harvesting in an Ant.* By P. A. Buxton, M.A., F.E.S., Formerly Medical Entomologist, Government of Palestine.

[Read December 5th, 1923.]

With Two Text-figures.

During the summer of 1923 I amused myself by watching a nest of Harvesting Ants (*Aphenogaster barbara* L.) in my garden in Jerusalem. At certain times of day no ants were above ground, at others they were harvesting actively, hundreds going out to their work along wide, beaten tracks many yards long, and returning carrying seeds and fragments of the dried stems and leaves of the annual vegetation, which had been dead for two months. The extreme uniformity of their movements suggested that they were controlled by some common physical stimulus. At the time at which the observations were made (June 1923) my garden was almost "desert," the more so as the winter rains had been deficient; the ground was quite bare and exposed to the sun, except in a few places where fruit trees cast their shade.

I found the activities of the ants extremely difficult to explain; they were curiously exact and co-ordinated, but one could seldom prophesy what they would do next. I began to record their activities as 0 (none above ground), 1 (a few individuals wandering round the nest crater), 2 (many doing so, but no organised harvesting going on), 3 (full activity, carefully organised); and at each time of observation I also noticed the dry and wet bulb temperature in a Stevenson's screen, the surface temperature of the ground by the nest, and the temperature at a depth of 6 inches (15 cm.) close to the nest. I accumulated a considerable number of observations, but for a long time could not discover what climatic factor caused or inhibited the activity of the ants. Generally speaking activity was 0 from 8.0 or 9.0 a.m. till 3.0 p.m.; the ants then became active very suddenly, and were often fully active (3) within half an hour of the first individual appearing above ground (1). From about 4.0 p.m. till midnight, and

often till nearly dawn activity continued full or nearly so (3), and it decreased very gradually until about 8.0 a.m., when it ceased. Such was very roughly their routine, but on certain days an activity of 1 or 2 continued all through the day, hundreds of ants being exposed to conditions above ground but none of them harvesting.

The first conclusion reached was that harvesting and other activities were determined by some condition above ground and not below ground. This I proved by experiment. There were several nests in my garden, though only one was studied in detail. I spread a sheet over this nest, and supported it about 1 foot from the ground, and kept it there for four days. This reduced the daily fluctuation of temperature at 6 inches in the soil, and reduced the daily maximum temperature at that depth. Without the sheet the day's maximum temperature at 6 inches was about 31·0–31·5° C., and this occurred at about 5–6.30 p.m.; the daily range of temperature was 4–4·5° C. When the nest was shaded the maximum was 27·0–30·5° C. and the daily range 2·5–3·5° C. The shading of the nest also reduced the soil surface temperature at the mouth of the nest from 55–62° C. to 44–51° C. at midday, and, as this disturbance did not affect the harvesting of the ants, I felt that one might argue that neither the soil surface temperature nor the temperature at six inches controlled the ants' harvesting. This argument is open to the objection that the shading only affected a few square yards of soil round the nest: the activities of the ants might well be determined by the surface temperature of the unshaded areas in which they gathered their seeds and pieces of vegetation. I next endeavoured to explain the events which I observed by supposing that they were controlled either by dry or wet bulb temperatures, or by relative humidity, but I found that apparently identical climatic conditions met with very different responses from the ants, as the following figures show (see table on p. 540).

Similar data might be multiplied, but I have given enough to show that one cannot explain the activity of the ants by studying the dry or wet bulb, or relative humidity alone; a similar conclusion will be reached if you combine two of these factors (*e. g.* dry bulb and relative humidity) and record the results on squared paper in two planes of space, for here again the result is merely confusing, great

Date.	Time.	Dry Bulb. °C.	Wet Bulb. °C.	Rel. Hum. Per cent.	Activity.
5th June	2.45 p.m.	33·0	20·5	30	0
,,	3.45 ,,	,,	,,	,,	2
6th June	3.15 ,,	34·5	20	22	0
,,	3.45 ,,	,,	19·5	21	1
,,	4.20 ,,	,,	,,	,,	2
9th June	2.10 ,,	26	16·5	35	0
,,	2.35 ,,	25·5	16	34	0
,,	3.5 ,,	,,	,,	,,	1
5th June	9.0 ,,	29	,,	21	3
10th June	9.5 a.m.	,,	,,	,,	0
9th June	4.10 p.m.	24	17	48	3
14th June	11.15 a.m.	,,	,,	,,	2
,,	12.20 p.m.	,,	,,	,,	1
,,	1.35 ,,	,,	,,	,,	2
5th June	4.10 ,,	33	19·5	25	3
11th June	5.40 a.m.	—	—	—	1
24th June	1.40 p.m.	—	—	—	0

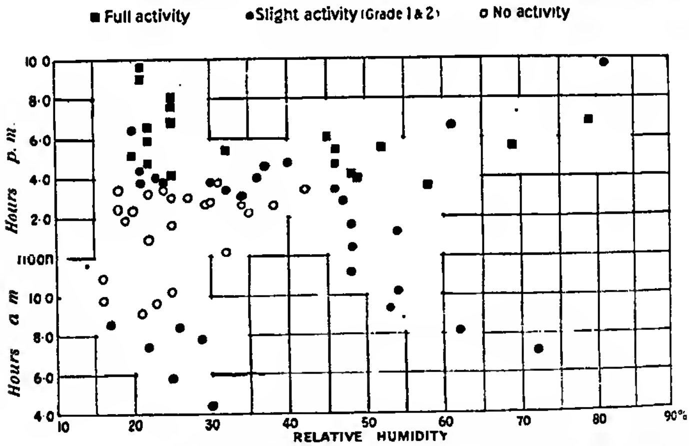


FIG. 1.—Showing the activities of *Aphenogaster barbara* at Jerusalem in June, charted with reference to hour of day, and relative humidity. It will be seen that there is a large area of complete inactivity through the midday hours, so long as the humidity is below 45 per cent.

activity and complete inactivity often being recorded at identical points on the graph.

As neither temperature nor humidity, nor a combination of the two, fitted the case, I wondered whether illumination would provide an explanation. Accurate photometry was not possible, but I assumed that, as the sky was clear

blue and quite cloudless, the intensity of light was the same an hour before noon as an hour after noon. Accepting this, light alone could not be regarded as an inhibitor of activity, because frequently the ants ceased to be fully active about 5.0–6.0 a.m. (*i. e.* 6 or 7 hours before noon), but were fully active at 4.0 p.m. (Figure 1). Moreover, there were certain cloudless days on which some degree of activity (1 or 2) persisted right through the middle of the

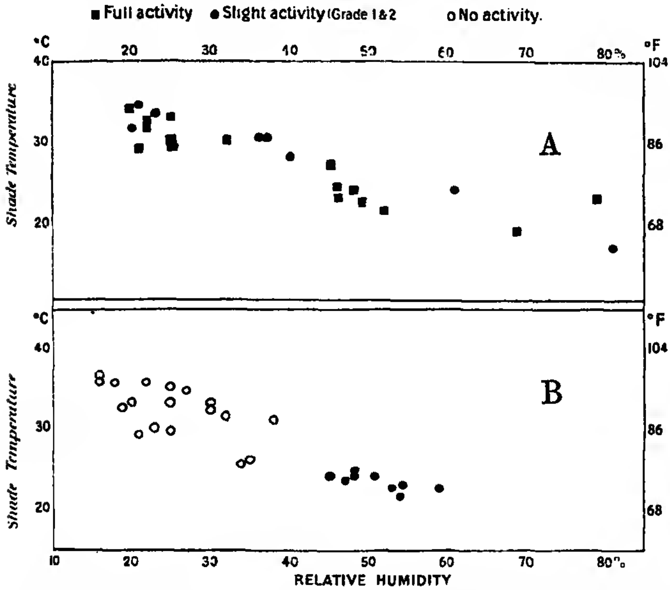


Fig. 2.—Showing the activity of the ants charted with reference to shade temperature and relative humidity. Chart A is for the hours 4.0 p.m. to midnight, B for the hours 9.0 a.m. to 3.0 p.m.

day. These were invariably days with a rather high (over 45 per cent.) relative humidity, in the middle of the day. When the facts are charted as in Figure 1, one reaches an explanation which is rather complicated, but which I believe to be the correct one, because no simpler one appears to cover the facts. The explanation which I put forward is as follows:—

1. The ants show tolerance for a wide range of temperature and humidity between 4.0 p.m. and midnight; in fact, they are always active to some extent during these hours, in the month of June: the graph in Figure 2, A,

shows this, and I may remark that the few occasions when activity was not full (3), were nearly all between 4.0 and 4.40 p.m.

2. Between 9.0 a.m. and 3.0 p.m. ants are never fully active; they show an activity of 1 or 2 when relative humidity is above 45 per cent., and they are totally inactive above ground when the humidity is below this figure. Some constituent of solar radiation inhibits their activity when the sun is high (9.0 a.m. to 3.0 p.m.), and this constituent is inoperative when the sun's rays are oblique (before 9.0 a.m., after 3.0 p.m.), or when the relative humidity during the middle of the day is unusually high.

I have discussed the point with several physicists, including Mr. E. A. Milne, of the Solar Physics Observatory, Cambridge; they all say that the inhibition must be due to the infra-red part of the solar spectrum. On normal days the infra-red rays heat the ground: it is known that water vapour cuts out exactly this part of the spectrum, and presumably with a relative humidity above 45 per cent. the surface of the earth is less hot at midday than when the air is drier. It is regrettable that I have not taken sufficient readings of surface temperature to confirm this.

3. Activity becomes less and less from midnight, or the early hours of the morning until 5.0–9.0 a.m., when it ceases, except on unusually damp days (see above). This very gradual slackening occurred every time that an observation was made, and is possibly a result of fatigue, or because so much material has been harvested that no further work is necessary. At any rate, it seems that temperature and humidity do not cause this cessation of activity, for it always occurs, though the temperature at that time of day was as high as 33° and as low as 18° C., and though the humidity ranged between 22 and 87 per cent. It is curious that the ants are not actively harvesting at this particular time of day, for it is just at this period (when the relative humidity is in general high) that the fragments of dried vegetation are absorbing moisture from the air, and one supposes that the very modest moisture requirements of the ants are satisfied by the water contained in the seeds and chaff which they collect and eat.

If the explanation which I have advanced is correct, and as I have said I have been unable to find a simpler one, it is interesting, because it shows that though the

factors which control the ants' activity are simple ones, yet their interaction produces a most complex result. If the inquiry had been extended further to include in its scope the behaviour of ants after heavy rain, and their winter sleep, the complexity of the result would have been still more striking. I believe that the method I have used for analysing the relationship between creatures and their physical environment will be found of value to the applied entomologist, and to the student of geographical distribution.

XXVI. Micro-Lepidoptera *of Rodriguez*. By EDWARD MEYRICK, B.A., F.R.S.

[Read December 5th, 1923.]

THE material here reviewed forms part of a large collection of insects made in Rodriguez by Mr. H. P. Thomasset and Mr. H. J. Snell between August and November, 1918, and presented to the University Museum of Zoology, Cambridge, in 1919. A list of the reports so far published on this collection has been given by Dr. Hugh Scott in an introductory note to F. W. Edwards' paper on the Diptera Nematocera of Rodriguez (Ann. Mag. Nat. Hist. (9) xii, p. 330, 1923). The types of the new species described in the following pages will be placed in the British Museum.

The island of Rodriguez lies 350 miles eastward of Mauritius, separated by ocean depths of over 2000 fathoms from the submerged bank (indicating a former great island) which extends from Mauritius to the Seychelles and was the home of the Mascarene fauna, of which in the *Micro-Lepidoptera* the principal representatives are the peculiar family *Metachandidae* and the Lyonetiad genus *Hieroxestis*. Rodriguez is volcanic (rising to 1300 feet), surrounded by a coral reef; it is only 40 square miles in extent, carries a population of 5000, and is mostly under cultivation. It was originally covered with dense tropical forest, of which few remnants are left; the endemic *Micro-Lepidoptera* are doubtless also only the relics of a much larger number. It would seem likely that the island was always isolated, and that its peculiar *Micro-Lepidoptera* can only be the descendants of wind-borne immigrants.

The specimens of *Micro-Lepidoptera* submitted to me were 202 in number, and all proved determinable. I am not aware of any previous records. The number of species now noticed is 34, of which 22 are described as new and are presumably endemic, whilst the other 12 occur elsewhere and are doubtless of external origin (apodemic). I believe that these 12 are all artificially introduced; their habits are not always known, but probably all are in the larval stage either feeders on domestic or crop refuse, or attached

to cultivated plants or common weeds; some, as *Trichoptilus congrualis* and *Cosmopteryx mimetis*, are extremely widespread.

Of the 22 endemic species 11, half of the whole, belong to the peculiar family *Metachandidae*; 4 are *Lyonetiadae*, 2 *Tineidae*, and there are single representatives of four other families, showing the strong individuality of the fauna.

The 11 *Metachandidae* fall in 3 genera, of which 2 are new; one of these contains 7 species, and is represented by 71 specimens, more than a third of the total number captured, indicating its predominance. This family cannot have originated in the Mascarene islands; its birthplace must have been in India, where there are a few species, of inconsiderable importance in a vast fauna; thence it crossed to the islands by way of the Chagos bank, and attained its maximum development in the absence of competitors; subsequently a small element reached Africa. The larvae will probably be found to feed on dead wood, lichens, and vegetable refuse, as usual in early island faunas.

The Lyonetiad genera *Hieroxestis* and *Oinophila* are characteristically African; these seem to have formed the secondary element in the fauna, having undergone considerable specific but not generic development. Their larvae feed in the same way on dead leaves and vegetable refuse. The single species of *Opogona* is of uncertain origin, the genus being spread throughout all warm regions.

The other genera may all be regarded as casual and more recent immigrants. *Bactra* is world-wide, and finds its food-plants (*Juncus* and *Scirpus*) in all lands. The *Pyroderces* is perhaps of African affinity, but the genus is also and more especially Indo-Australian; the larvae are refuse-feeders. *Orygocera* is solely African, as noted below. *Simaethis* is cosmopolitan, but especially attached to *Moraceae*, particularly *Ficus*. *Xyrosaris*, though not an extensive genus, is also nearly cosmopolitan. The new genus *Ogmocoma* is of uncertain immediate affinity. *Latypica* is a small Indian genus, but has also African species. I have not much material from Madagascar, but such as there is gives no evidence of any connection with these islands.

PTEROPHORIDAE.

Trichoptilus congrualis Walk.

10 ex. Cosmopolitan in hot countries.

Trichoptilus wahlbergi Zell.

10 ex. African and Indo-Australian.

TORTRICIDAE.

Adoxyphyes ergatica Meyr.

♂. 16–17 mm. Fore-wings with slender costal fold on basal fifth, termen almost straight, vertical; pale ochreous, sometimes strewn with reddish-fuscous strigulae; markings variable in development, red-brown mixed fuscous and dark brown, sometimes strongly-marked; central fascia narrow, irregular-edged, from before middle of costa to before tornus; costal patch flattened-triangular: cilia pale ochreous. Hind-wings pale greyish, costal half suffused ochreous-whitish.

7 ex. (5 ♂, 2 ♀). Described from the Seychelles, on females only, hence the specific identity is not absolutely assured; the female examples are somewhat lighter, more strigulated, and less suffused than the three known from the Seychelles, but I am unable to regard them as distinct; the male might, however, have more definite characters. This species is in any case subject to considerable variation.

EUCOSMIDAE.

Spilonota sinuosa Meyr.

1 ex. (♀). South African. Probably attached to a cultivated Myrtaceous tree or shrub.

Crocidosema plebeiana Zell.

4 ex. Cosmopolitan in warm countries; introduced with *Malvaceae* in gardens.

Bactra transvola, n. sp.

♂. 13 mm. Head, palpi, thorax light ochreous speckled fuscous. Fore-wings apex obtuse, termen nearly straight, faintly sinuate,

rather oblique; light brownish-ochreous, slightly sprinkled fuscous; costa, dorsum, and termen marked throughout with very short dark fuscous strigulae; a suffused brown stripe mixed blackish slightly downcurved from base of dorsum below middle of wing to apex; two small obliquely superposed brown marks indicating interior of ocellus: cilia pale ochreous obscurely barred fuscous, at apex a blackish bar. Hind-wings pale grey, without whitish tinge; cilia whitish-grey.

1 ex. Though nearly related to the common South African *stagnicolana*, this appears to be distinct from it, as also from the Seychelles *legitima*, which, however, is only known from two female examples. This difficult genus requires much caution, but it is unlikely that the species are artificially introduced, and hence there is a *prima facie* case for provisional separation, awaiting further material.

Polychrosis ephippias Meyr.

5 ex. Indo-Malayan and African, probably attached to some cultivated plant.

GELECHIADAE.

Brachmia convolvuli Wals.

4 ex. Indo-Malayan and African, introduced with its food-plant.

METACHANDIDAE.

Metachanda malevola, n. sp.

♂♀. 8–9 mm. Head and thorax light ochreous-greyish. Palpi ochreous-whitish, anteriorly suffused dark grey, terminal joint dark fuscous except tip. Fore-wings apex obtuse, termen very obliquely rounded; ♂ dark grey, ♀ dark fuscous; direct transverse fasciae of ochreous-whitish irroration edged with irregular ochreous-whitish lines at $\frac{1}{4}$ and hardly beyond middle; an irregular angulated ochreous-whitish line from $\frac{5}{8}$ of costa to tornus: cilia whitish-grey, one or two whitish basal dots about apex. Hind-wings ♂ grey, suffused blackish-grey except posteriorly, cilia whitish; ♀ pale grey, cilia ochreous-whitish.

5 ex. (2♂, 3♀).

Metachanda sublevata, n. sp.

♂♀. 8–9 mm. Head and thorax dark bronzy-fuscous. Palpi whitish-ochreous slightly sprinkled dark fuscous, terminal joint suffused dark fuscous except towards base. Fore-wings apex obtuse-pointed, termen very obliquely rounded; dark purplish-fuscous; a slender nearly straight hardly oblique white fascia at $\frac{2}{5}$, anteriorly sharply dark-edged, posteriorly suffused and followed by a broader ochreous fascia, plical and first discal stigmata sometimes visible as small dark fuscous spots on posterior edge of this; second discal forming a small dark fuscous spot, a similar more conspicuous spot obliquely below and before it, surrounded by some ochreous suffusion; a suffused whitish spot on costa at $\frac{3}{4}$, whence a slender indistinct ochreous angulated line runs to tornus; some pale ochreous irroration or suffusion round apex and termen: cilia greyish, a blackish subbasal line cut by some pale ochreous bars. Hind-wings dark grey; cilia grey.

7 ex.

Metachanda declinata, n. sp.

♀. 12 mm. Head and thorax whitish-ochreous, shoulders fuscous. Palpi ochreous-whitish, second joint infuscated except apex. Fore-wings apex obtuse, termen obliquely rounded; whitish-ochreous, some scattered fuscous specks; an elongate dark fuscous spot along basal fifth of costa; a dark fuscous flattened-triangular spot along costa from $\frac{1}{3}$ to $\frac{2}{3}$; some ferruginous-brownish suffusion in disc and towards median area of dorsum; a trapezoidal fuscous blotch on tornus, marked dark fuscous anteriorly, from this an irregular fascia of brownish suffusion sprinkled dark fuscous extends along termen to costa; a slight oblique dark fuscous mark on costa at $\frac{2}{3}$: cilia whitish-ochreous mixed fuscous (imperfect). Hind-wings pale grey; cilia grey-whitish, a light grey subbasal line.

1 ex.

SEMNOCOSMA, n. g.

Head smooth; ocelli posterior; tongue developed. Antennae $\frac{4}{5}$, basal joint moderately elongate, without pecten. Labial palpi long, recurved, second joint thickened with appressed scales, terminal joint half second, moderate, acute. Maxillary palpi very short, filiform, appressed to tongue. Posterior tibiae rough-scaled above. Fore-wings 1*b* furcate, 2 from near angle, 7 absent, 11 from middle. Hind-wings 1, trapezoidal-ovate, cilia $\frac{1}{3}$; 4 absent, 3 and 5 remote, 6 absent.

Differs structurally from the following genus only by the short terminal joint of palpi, but the aspect is quite peculiar, and perhaps the ♂ may show special characters.

Semnocosma necromantis, n. sp.

♀. 27 mm. Head and thorax shining bronzy-purplish, orbits pale yellowish. Palpi pale ochreous-yellowish, anterior edge of terminal joint dark fuscous, terminal joint half second. Fore-wings apex rounded-obtuse, termen rounded, rather oblique; dark fuscous-purple, suffusedly irrorated whitish, towards base of costa tinged indigo-blue; the absence of irroration indicates an undefined slender dark streak along costa and termen, a dark transverse mark on end of cell, and a spot of dark suffusion on tornus: cilia dark fuscous-purplish, towards tips on termen pale greyish-ochreous. Hind-wings dark purplish-fuscous; cilia greyish, a darker purplish-grey subbasal shade.

1 ex. The largest and most striking species in the collection; it seems allied to the South African *Daemonarcha cyprophanes*. The single specimen (in fine condition) is abnormal in neuration, and would have been puzzling if I had not been well acquainted with this peculiar family type; in one fore-wing vein 4 is forked from near origin, in the other vein 5 is similarly forked; hence it would be supposed that the full number of veins is present, but that they are differently compounded on each side; in fact vein 7 is absent (as usual), and these furcations are supernumerary growths.

CENARCHIS, n. g.

Head with appressed scales; ocelli posterior; tongue developed. Antennae $\frac{4}{5}$, in ♂ shortly ciliated, basal joint moderately elongate, without pecten. Labial palpi very long, recurved, second joint with appressed scales, terminal joint from $\frac{3}{4}$ to nearly 1, moderate, acute. Maxillary palpi very short, filiform, appressed to tongue. Posterior tibiae rough-scaled above. Fore-wings 1*b* furcate, 2 from near angle, 7 absent, 11 from middle. Hind-wings 1, trapezoidal-ovate, cilia $\frac{1}{2}$; 4 absent, 3 and 5 remote, transverse vein obsolete, 6 absent.

Type *vesana*. Differs from *Metachanda* by veins 3 and 5 of hind-wings being remote at base instead of connate.

Cenarchis capitolina, n. sp.

♂. 16 mm. Head and thorax pale brownish-ochreous sprinkled or mixed fuscous. Palpi pale ochreous sprinkled dark fuscous. Fore-wings elongate, costa gently arched, apex obtuse, termen obliquely rounded; light brownish-ochreous irrorated fuscous; base pale ochreous limited by a suffused dark fuscous subbasal fascia; stigmata dark fuscous, plical almost beneath first discal, second discal transversely double; an elongate suffused pale ochreous mark on costa at $\frac{3}{5}$, preceded and followed by darker suffusion; about three obscure dark dots on veins towards termen, and some darker suffusion on apex and upper part of termen: cilia pale ochreous obscurely barred fuscous. Hind-wings grey; cilia pale greyish.

2 ex.

Cenarchis liopsamma, n. sp.

♂♀. 11–15 mm. Head and thorax brownish-ochreous, sometimes sprinkled dark fuscous. Palpi ochreous-whitish, more or less sprinkled dark fuscous. Fore-wings apex obtuse, termen obliquely rounded; brownish-ochreous or pale ochreous, sometimes variably irrorated brownish or dark fuscous; markings variable in development, in pale specimens sometimes mostly obsolete; stigmata brownish or fuscous, seldom dark fuscous, plical somewhat obliquely beyond first discal, these sometimes edged with one or two whitish scales posteriorly, second discal transversely double, sometimes an additional dot between and above discal; a pale spot indicated on costa at $\frac{3}{5}$, preceded and followed by indistinct spots of darker suffusion; in darker specimens a more or less perceptible angulated subterminal series of cloudy dark dots from latter of these to a spot before tornus: cilia pale greyish-ochreous, an interrupted fuscous subbasal shade. Hind-wings grey-whitish or whitish-grey, towards apex light grey; cilia whitish or whitish-grey.

21 ex.

Cenarchis vesana, n. sp.

♂♀. 12–14 mm. Head and thorax fuscous sprinkled darker. Palpi dark fuscous sprinkled whitish, apex of second joint whitish. Fore-wings apex obtuse, termen rather obliquely rounded; fuscous sprinkled darker; markings cloudy, dark fuscous, variable in development, viz., a spot on costa near base sometimes followed by an indistinct whitish-ochreous spot, an indistinct spot on fold towards base, roundish spots representing stigmata and often accompanied posteriorly by ochreous-whitish dots, plical rather obliquely beyond

first discal, a spot between and above first and second discal, dark fuscous suffusion extending along posterior half of costa including a small whitish-ochreous or whitish usually distinct spot at $\frac{3}{5}$ and one or two smaller and usually less distinct posteriorly, and an acutely angulated series of cloudy dark dots from beneath costa beyond $\frac{3}{5}$ to a spot on dorsum before tornus: cilia pale greyish, on basal half tinged whitish-ochreous and obscurely spotted fuscous. Hind-wings grey or dark grey; cilia grey.

33 ex.

Cenarchis plectrophora, n. sp.

♂♀. 11 mm. Head and thorax dark grey sprinkled white. Palpi white sprinkled dark fuscous, second joint with basal half and a subapical ring dark fuscous. Fore-wings apex obtuse, termen obliquely rounded; dark grey irregularly sprinkled white; a short oblique blackish streak from base of costa, followed by a patch of white suffusion; a white elongate mark on middle of costa, preceded and followed by suffused dark fuscous spots, costa posteriorly with three white dots separated by dark fuscous suffusion; stigmata indistinct, blackish, plical beneath first discal, second discal transversely double; more pronounced white irroration extending from middle of disc to apex and upper part of termen: cilia white mixed grey, basal half indistinctly barred dark fuscous. Hind-wings grey; cilia pale grey.

1 ex.

Cenarchis celebrata, n. sp.

♂. 12 mm. Head and thorax fuscous mixed whitish. Palpi dark fuscous irrorated whitish, second joint with whitish apex and dark fuscous subapical band. Fore-wings apex obtuse, termen obliquely rounded; dark grey, strongly and suffusedly irrorated white; a moderate semi-oval dark fuscous spot on base of costa surrounded with white suffusion; a small dark fuscous spot on fold towards base; small blackish spots representing stigmata, plical rather obliquely beyond first discal, second discal transverse, an additional spot obliquely before and above second discal; a white spot on costa at $\frac{3}{5}$ preceded and followed by small blackish spots, costa posteriorly white with three blackish dots; a subterminal series of blackish dots, acutely angulated near apex, from beneath costa at $\frac{3}{4}$ to a triangular spot of dark suffusion on tornus: cilia grey suffusedly barred white. Hind-wings grey; cilia white, a light grey subbasal shade.

1 ex.

Cenarchis priscata, n. sp.

♂♀. 13–16 mm. Head and thorax white finely speckled fuscous. Palpi white with some dark fuscous specks, second joint with basal half and a subapical ring dark fuscous. Fore-wings apex rounded-obtuse, termen obliquely rounded; grey variably and irregularly irrorated white, in ♀ sometimes minutely speckled blackish; an oblong fuscous spot on base of costa; a small grey spot on costa before middle, and several smaller ones towards apex, separated by more or less developed white suffusion; a short longitudinal line of black specks towards costa preceding antemedian spot; stigmata obscure, grey, with two or three black scales, but sometimes small, well-marked, black, plical hardly beyond first discal; a cloudy dark dot towards costa at $\frac{3}{4}$; a slightly curved subterminal series of several obscure cloudy grey dots: cilia whitish spotted with grey irroration. Hind-wings grey; cilia whitish-grey, a darker subbasal line.

11 ex.

Cenarchis veterata, n. sp.

♀. 15–16 mm. Head and thorax grey mixed white. Palpi white with some dark fuscous specks, base and a subapical ring of second joint, and base of terminal joint dark fuscous. Fore-wings apex rounded-obtuse, termen rounded, rather oblique; white irrorated dark grey; markings dark fuscous, viz., a dot on base of costa, an irregular oblique streak near base in disc, small round spots representing stigmata, plical obliquely beyond first discal, additional similar spots obliquely above and before first discal, between first discal and plical, and above and between first and second discal, a dot on costa before middle, an acutely angulated series of dots from beneath costa at $\frac{3}{4}$ to a small spot on dorsum beneath second discal, and a marginal series of small dots round posterior part of costa and termen: cilia white, a subbasal series of dark fuscous spots alternating with marginal dots. Hind-wings light grey; cilia pale greyish.

2 ex.

COSMOPTERYGIDAE.

Cosmopteryx mimetis Meyr.

1 ex. Occurs in most tropical and warm temperate regions, spread with its food-plant, Cyperus rotundus.

Pyroderces subcarnea, n. sp.

♂♀. 13–15 mm. Head light ochreous. Eyes crimson. Palpi whitish, second and terminal joints each with three dark fuscous rings. Thorax light pinkish-grey. Fore-wings pale pinkish with tips of scales light grey, appearing to form a very fine transverse striation; a fine irregular zig-zag oblique transverse whitish line about $\frac{1}{4}$, edged anteriorly with blackish marks beneath costa end beneath fold; an elongate black dot in disc before middle, edged white except beneath, from this a fine acutely angulated whitish line runs to dorsum beneath it; an elongate black dot in disc at $\frac{3}{4}$, edged below by a whitish dash, an oblique whitish striga from dorsum below this, and two very oblique more indistinct strigae from costa rather before it; wedge-shaped black marks partially edged whitish on costa and termen near apex: cilia whitish tinged grey towards base, at apex a black basal dot. Hind-wings light grey, apex tinged whitish; cilia light grey, more whitish towards tips.

5 ex.

OECOPHORIDAE.

Orygocera Wals.

Only three specimens of this genus have been recorded, constituting two species West and East African respectively. These were all males; the present discovery of a third species in copious material is not only very interesting geographically, but also discloses the fact that the peculiar structural character of the absence of vein 11 in fore-wings is a male sexual feature, not shared by the female, in which this vein is well-developed as usual, but rising from $\frac{1}{3}$ of cell, as in *Epiphractis* and the *Diocosma* group. This position of the vein in question makes it improbable that its disappearance in the male is attained by coincidence with 10, as I had conjectured; but I note that in *Epiphractis amphitricha* ♂ this vein exhibits a weakening or tendency to obsolescence, probably connected with the development of the sexual fringe of long hairs on vein 12.

Orygocera lenobapta, n. sp.

♂♀. 18–22. Head whitish-ochreous, in ♂ more or less tinged or suffused fuscous-purplish. Palpi whitish-ochreous irrorated crimson-purplish, terminal joint $\frac{2}{3}$–$\frac{4}{5}$. Thorax pale ochreous, often tinged or suffused ferruginous or fuscous-purplish. Fore-wings

apex obtuse, termen rather obliquely rounded; 9 curved and approximated at base to 8; pale ochreous, in ♀ tinged whitish and variably sprinkled ferruginous, in ♂ wholly suffused fuscous-purplish or purple-brown; markings cloudy, indistinct or sometimes little apparent, in ♀ ferruginous or red-brown, in ♂ dark purple-fuscous, indicating when well-developed a streak along dorsum, enclosing a short pale basal streak, and small subtriangular pale antemedian and praetornal spots, and oblique streaks crossing disc at $\frac{1}{3}$ and $\frac{2}{3}$, latter bent in beneath to touch apex of praetornal spot: cilia in ♀ reddish-brown, in ♂ fuscous-purplish. Hind-wings in ♂ grey, in ♀ ochreous-whitish posteriorly suffused dull rosy; cilia ♂ grey, ♀ ochreous-whitish.

22 ex.

GLYPHIPTERYGIDAE.

Simaethis turilega, n. sp.

♀. 12 mm. Head and thorax fulvous-brownish speckled whitish. Palpi with four series of dark fuscous white-tipped scales. Forewings 7 separate; orange-fulvous, suffusedly irrorated blackish with a few whitish scales on basal $\frac{2}{3}$ and a terminal fascia, latter suffused deep ferruginous; two whitish shades rising from small white costal spots, first nearly straight at $\frac{1}{3}$, second at $\frac{2}{3}$ forming a broad undefined loop extending from beneath costa to below middle, thence irregular to dorsum. Hind-wings dark fuscous; an ill-defined moderate streak of whitish suffusion from base to $\frac{2}{3}$ of disc; cilia whitish, a dark fuscous subbasal line.

1 ex., in indifferent condition.

HYPONOMEUTIDAE.

Xyrosaris obtorta, n. sp.

♂♀. 12 mm. Head, palpi, and thorax white speckled fuscous. Fore-wings narrow; white speckled fuscous, more densely irrorated on costal half; markings dark fuscous, more strongly marked in ♂; several dots on costa towards base, and two obliquely placed in disc towards base; a very irregular oblique transverse streak about $\frac{1}{3}$; two dots following this near costa and dorsum, and two nearly longitudinally placed in disc beneath middle; cloudy blotches beneath costa before middle and at $\frac{2}{3}$, latter obliquely connected with costa beyond it; a small spot or large dot above tornus; a small white spot surrounded with dark suffusion on costa at $\frac{5}{6}$; apical area beyond this suffused purplish-fuscous; in the ♀ these

markings are less developed, the most conspicuous being a dark submedian spot on the antemedian streak, the dark spot above tornus, and the white praeapical spot followed by a dark spot: cilia rather dark fuscous, on tornus greyish. Hind-wings light grey, thinly scaled; cilia concolorous.

2 ex.

LYONETIADAE.

Oinophila canthopa, n. sp.

♀. 7 mm. Head and thorax pale ochreous. Antennae nearly 1. Fore-wings lanceolate, caudate; pale ochreous, a few scattered black scales; a black dot on dorsum at $\frac{1}{4}$, a large elongate black dot in disc at $\frac{3}{4}$, and an irregular black apical dot: cilia whitish-ochreous. Hind-wings pale grey; cilia ochreous-whitish.

1 ex. Closely related to the South African *amphicrossa*, but distinct.

Oinophila serrata Meyr.

1 ex. Also in East Africa.

Opogona iridogramma, n. sp.

♀. 7 mm. Head and thorax dark violet-fuscous, face and fillet pale shining ochreous. Fore-wings lanceolate; dark purple-blue-fuscous; a slender straight transverse pale iridescent-metallic line before middle, a similar transverse mark from costa at $\frac{2}{3}$, a dot on costa before apex, and one on tornus: cilia dark fuscous. Hind-wing and cilia rather dark bronzy-fuscous. Fore-wings beneath strongly iridescent.

1 ex. The labial palpi are missing, maxillary normal; neuration not wholly decipherable, but the species is probably a true *Opogona* allied to the *chalinota* group, but peculiarly distinct.

Hieroxestis chrysodora, n. sp.

♀. 7 mm. Head and thorax purple-blackish, face, fillet, and short projecting occipital fringe of hairs pale shining ochreous. Fore-wings lanceolate, apex acutely produced; black mixed with some elongate pale yellowish scales; narrow transverse fasciae of raised golden-metallic scales before middle and at $\frac{5}{8}$; basal area, except on costa and a narrow margin to first fascia, purple-golden-metallic;

dorsal half between fasciae purple-golden-metallic: cilia dark purple-fuscous. Hind-wings dark bronzy-fuscous; cilia dark fuscous.

1 ex. This small but splendid and distinct insect is in much damaged condition; the labial palpi are represented only by their basal joints, the maxillary are shorter than usual but distinct; the neuration cannot be properly deciphered in the condition of the specimen, but I rely on the characteristic structure of the head.

Hieroxestis autogama Meyr.

22 ex. Also in the Seychelles.

Hieroxestis omoscopa Meyr.

5 ex. Also in South Africa (which I suppose to be its native home), and introduced in Mauritius, Australia, New Zealand, Norfolk I., and Lord Howe I.

Hieroxestis subcervinella Walk.

10 ex. Also in Mauritius, the Seychelles, and Madeira.

Hieroxestis sciadocoma, n. sp.

♀. 9 mm. Head white, occipital tuft long, broad, flat, projecting, grey. Palpi white, second joint with black external streak. Thorax grey, two white lines, patagia ferruginous, edged whitish externally. Fore-wings elongate-lanceolate; dark fuscous, blackish towards costa posteriorly; markings snow-white; a streak along costa from base to first striga; two extremely oblique strigae from costa before middle and at $\frac{3}{4}$; a moderate median streak from base to middle; a slightly sinuate streak from above middle of dorsum close beneath posterior portion of this to upper half of termen and apex: cilia white, basal half grey on termen, at apex a fine black projecting bar and dark fuscous hook above this, between these a small brown spot. Hind-wings and cilia rather dark bronzy-grey.

1 ex.

TINEIDAE.

Ogmocoma, n. g.

Head with long dense rough hairs on crown and similar frontal tuft appressed to these, only marked off by slight furrow, lower part

of face shortly rough-scaled; ocelli posterior; tongue absent. Antennae 1, in ♂ simple, joints closely set, basal joint elongate, stout, without pecten. Labial palpi moderate, porrected, second joint slightly curved, with appressed scales and several external projecting bristles, terminal joint as long as second, more slender, obtuse. Maxillary palpi moderate, folded, loosely scaled. Posterior tibiae rough-haired above. Fore-wings 1*b* furcate, 2 from $\frac{4}{5}$, 3 from angle, 5 and 6 out of 7, 7 to costa, 11 from before middle. Hind-wings $\frac{2}{3}$, lanceolate, cilia 2; 2 and 3 parallel, 4 absent, 5–7 somewhat approximated towards base.

A specialised form of the *Tinea* group.

Ogmocoma pharmacista, n. sp.

♂. 16 mm. Head pale ochreous. Palpi, antennae, and thorax dark fuscous. Abdomen pale whitish-ochreous. Fore-wings elongate-lanceolate; rather dark fuscous, with faint violet tinge; some blackish scales in disc towards base; very small violet-blackish spots on costa before middle and at $\frac{3}{4}$; some narrow undefined dark fuscous suffusion along dorsal and terminal edge: cilia pale greyish, at apex a bar of light fuscous suffusion. Hind-wings pale greyish, tinged whitish-ochreous; cilia ochreous-grey-whitish.

1 ex.

Latypica malacista, n. sp.

♂. 16 mm. Head and thorax whitish-ochreous, irregularly sprinkled and mixed dark fuscous. Palpi whitish-ochreous slightly sprinkled dark fuscous, lower part of second and terminal joints dark fuscous, terminal joint obtuse. Fore-wings apex obtuse, termen very obliquely rounded; light ochreous-brownish, obscurely freckled whitish; small irregular spots and marks of blackish irroration along costa; a light fuscous streak edged with obscure dots of blackish irroration from costa at $\frac{1}{3}$ obliquely to fold, thence above fold to $\frac{3}{5}$ of wing; an elongate undefined patch of irregular blackish irroration extending from end of cell to termen below middle, two or three more distinct blackish dots on termen: cilia whitish-ochreous tinged brownish and slightly speckled dark fuscous near base. Hind-wings light grey; cilia whitish.

1 ex. Allied to the African *crispa*.

XXVII. *Some Coleopterous Remains from the Peat-bed at Wolvercote, Oxfordshire.* By K. G. Blair, B.Sc., F.E.S.

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[Read December 5th, 1923.]

A PRELIMINARY account of some of these fragments was given by Prof. Poulton at the meeting on 7th March last (*vide* Proc. Ent. Soc. London, 1923, pp. xv–xvii), but since that date further material has come to light which, together with more accurate determination of that previously examined, has made a more complete account now practicable.

The remains occurred in a peaty band about two inches thick which had been deposited at the bottom of a running stream, and are referred by Capt. K. S. Sandford to late Acheulean or possibly early Mousterian age, *i.e.* contemporary with Lower Palaeolithic man. The fragments have unfortunately been isolated from their matrix, some of them being unmounted, others mounted in dry cells or in Canada balsam. Except for one irregular piece of chitin that has so far defied recognition, all consist of elytra, many of them fairly complete.

As far as identified they represent the following species :—

1. **Notiophilus** cf. **aquaticus** L.* R. elytron. The colour is black without the metallic lustre of modern specimens, and the 3rd interstice is wider than the 4th; the whole is more or less wrinkled transversely, but this is probably due to the conditions of preservation.

The species has also been identified in the Dogger Bank deposits.

(Present habitat: Common and generally distributed.)

2. **Harpalus** cf. **dimidiatus** Rossi. L. elytron, portion, about the apical third and all the external portion outside the 7th interstice lacking. From modern specimens it differs in the basal carina being straight instead of feebly

* *I.e.* species "comparable with" *N. aquaticus* L. rather than positively identical with it.

arcuate, and in the sutural stria being free behind instead of uniting with the first complete stria. The microsculpture of the intervals though indistinct appears to be similar to that of the ♂.

This specimen is No. 2 of the set previously reported upon, and there assigned with some doubt to *Amara.*

(Chalky hillsides and salt marshes, under stones, etc. Apparently confined to the southern and south-eastern districts of England.)

3. **Synuchus** cf. **nivalis** Panz. R. elytron practically complete, L. elytron with apex wanting. Agrees well with modern specimens except that the scutellary stria unites with the first complete stria, leaving the anterior portion of the latter detached.

The left elytron is No. 3 of the earlier set, when it was provisionally assigned to *Amara.*

(Damp places; widely distributed.)

4. **Patrobus** sp. (?). R. elytron with the suture and apical half intact; but the whole of the base and humeral region wanting. Most nearly resembles *Patrobus assimilis,* Chaud. of existing species; striae rather indistinctly punctured towards the base, but smooth in posterior half; 3 and 4 apparently confluent behind, also 5 and 6; microsculpture on interstices indistinct, finely transversely reticulate.

This specimen is No. 4 of the earlier set, and was then provisionally assigned to *Amara.*

(Damp places; two of the three British species are boreal or mountain species.)

5. **Geodromicus** cf. **nigrita** Müll. Two elytra mounted in balsam on separate slides are of exactly the same size and dimensions and belong apparently to the same species; they are probably assignable to this species.

(By the side of lakes, streams, etc. Now only in the north of England, Scotland and Ireland.)

6. **Geodromicus** cf. **globulicollis** Mann. An elytron mounted on the same slide with one of the above is shorter and comparatively broader, evidently of a different species. It agrees well with modern specimens of this species.

(In moss; a highland and alpine species. Snowdon and Scotland.)

7. **Donacia** cf. **simplex** F. An elytron with both base and apex wanting exhibits sculpture very similar to that of *D. simplex,* but with even more regular transverse ridging

across the interstices. The colour is blackish-blue, not so bright as that of the blue form of the existing species.

This is No. 1 of the earlier series.

(Common and widely distributed in the neighbourhood of water.)

8. **Donacia** cf. **sericea** L. Three elytra, all R., mounted on the same slide seem to agree better with this than with any other existing British species. The colour is nearly black, with more or less dark blue reflections. A fourth elytron, L., is mounted on a separate slide.

(Like the last.)

9. **Otiorrhynchus** cf. **ligustici** L. No. 5 of the earlier series, at the time not satisfactorily determined, agrees very well with modern specimens of this species, a few of the opalescent scales, or parts of scales, remain still adherent to the surface. The fragment is a portion only of one elytron, with a part of the basal declivity to give its orientation.

(Heathy places; rare in England, but often injurious to crops on light land in France.)

10. **Trachyphloeus** cf. **aristatus** Gyll. An elytron, L., mounted in balsam, is probably referable to this species. It is almost intact, though crumpled and split owing to the flattening of its highly convex form.

(Sandy and chalky places.)

11. **Notaris** (**Erirrhinus**) cf. **aethiops** F. Four elytra mounted separately, but not all in an equally good state of preservation, are probably all of the same species, those in better condition agreeing well with modern specimens of *N. aethiops*.

(Marshy places, edges of drains, etc. Now only in the north of England, Scotland and Ireland.)

12. **Notaris** ? sp. The basal portion of an elytron, R., similar in size to the last and resembling them in many ways, is probably assignable to a different species. The punctures of the striae are large, very sharply cut, almost tuberculate laterally, but more sloping antero-posteriorly; interstices with small scattered pores, each eccentric to an indistinct darker circle (? tubercle). (Balsam mount.)

13. **Curculionidae**, gen. ? L. elytron, $2\frac{3}{4}$ mm. by $1\frac{1}{2}$ mm., less convex and less declivous at apex than *Trachyphloeus*; humeral callus well marked; 10 striae of large shallow punctures almost contiguous in the striae with intervals of about one diameter between the rows,

each puncture with a minute central (originally probably setigerous) tubercle. The punctures are rather indistinct, and the termination of the striae is not discernible (balsam mount).

14. **Curculionidae** (? **Baris** sp.). L. elytron. $3\frac{1}{2}$ mm. $\times$ $1\frac{1}{2}$ mm., convex, rather strongly declivous behind, with 9 deep perpendicular-sided striae with shallow, rather distant punctures that scarcely crenulate the interstices; sutural stria intact, not approaching scutellum, and extending to apex; 2nd to 4th, and 7th to 9th all ending separately a little before the apex, 5th and 6th confluent, and then produced, shorter; base indistinct, but first four striae appear to reach it, the 5th to 8th falling successively further short of doing so; 9th subhumeral, again longer; intervals shining, without evident microsculpture; humeral callus fairly distinct. The striae are distinctly Barid in character, but not the intervals; possibly not this subfamily at all.

15. An irregularly shaped piece of chitin, about 2 mm. square, black, coarsely and densely punctate, and somewhat rugose, with a tendency to the formation of pustules near one side. Probably from the ventral surface of some Coleopteron, but almost certainly specifically distinct from any of the above.

(No. 6 of the earlier set.)

The identification of these fragments with species still extant is in some cases open to doubt. In many cases even existing species are separable only on the comparison of parts not represented in our fragments, and the most we can claim is that on comparison of our fragments with the corresponding portions of existing species the resemblance is sufficiently close to warrant our provisional assumption of identity on the evidence to hand. We can at least say that our fragment more closely resembles the existing species than do any of its present-day relatives. Exactly what amount of alteration, if any, the facies of the species has undergone during the lapse of time involved it is impossible to say, since many of the points of difference noted, *e.g.* the course of the scutellar stria, are subject to considerable individual variation. There is one point, however, that is suggestive; the genus most abundantly represented in peat deposits from various localities and of various ages is *Donacia*, of which fragments of several different species have been found, e.g. *sericea*, *simplex*,

obscura, etc. All the elytra from peat that have come under my notice have been blue, a colour that is still fairly common in *sericea*, less so in *simplex*, and apparently very rare or unknown in *obscura*. The suggestion is that blue is a primitive colour in this genus, and that the variety of colours we now find is a comparatively modern evolutionary development.

Of the fifteen species represented at least ten are practically identified with existing British species, while the probability is that the remainder will also prove to be so when fully determined.

Of those of which at present we can say anything of the probable habits eight, *Notiophilus*, *Synuchus*, *Patrobus*, *Geodromicus* (2), *Donacia* (2), and *Notaris*, are partial to the waterside or wet places (but are not essentially fenland species); while three, *Harpalus*, *Otiorrhynchus* and *Trachyphloeus*, prefer sandy or chalky districts; though many of them are now local, six, *Notiophilus*, *Synuchus*, *Donacia* (2), *Otiorrhynchus* and *Trachyphloeus*, are still of wide distribution in Great Britain, while three, *Geodromicus* (2) and *Notaris*, no longer exist in the south. One, on the other hand, *Harpalus*, is now only found in the south-eastern counties. From this we can conclude that the climatic conditions at the time these insects were alive were not greatly different from those of the present day, though the proportion of what are now boreal species suggests that on the whole it was somewhat colder and more subarctic in character. The presence of the *Harpalus* is a little contradictory, but may be explained by supposing that the range of the species has since become more restricted.

The condition of the specimens is firm, though usually more or less crumpled. In some cases, and probably the same remark applies to all, it can readily be seen that only the harder more strongly chitinised upper membrane of the elytron has been preserved, the softer internal substance and probably the lower membrane having disappeared. Thus the specimens of *Donacia* and *Otiorrhynchus* exhibit a dull underside with the punctures projecting as a series of pegs. The dull surface, however, appears to show traces of a minute reticulation which may represent the lower membrane closely adpressed on to the upper, owing to the compression or loss of the softer internal substance.

Compared with the beetle remains from other peat

deposits examined, notably those of the Dogger Bank in the North Sea, and of Ireland, we find only one genus, *Donacia*, common to all, though *Geodromicus* has been identified from the Irish peat and *Notiophilus* in the North Sea "Moorlog." It must be borne in mind that the present series of fragments was from a small local deposit that stratigraphical evidence shows to have been laid down in the bottom of a running stream, so that we should not expect to find the same fauna as from an extensive area of fenland.

Another point on which comparison is interesting is the fact that in this series all the fragments but one consist of elytra, whereas in the others there is a considerable proportion, even preponderance, of heads, limb-joints, and portions of the body sclerites. This is presumably to be accounted for by the supposition that in this case the elytra were considered to be the only parts offering any chance of recognition, and hence the only parts worthy of preservation.

XXVIII. *Mimicry in the Butterflies of Fiji considered in relation to the Euploeine and Danaine invasions of Polynesia and to the female forms of* Hypolimnas bolina *L. in the Pacific.*

By EDWARD B. POULTON, M.A., D.Sc., F.R.S., Hope Professor of Zoology in the University of Oxford, Fellow of Jesus College, Oxford. With an Appendix On the Numerical Aspect of Reciprocal Mimicry (Diaposematic Resemblance), by H. H. TURNER, M.A., D.Sc., F.R.S., Savilian Professor of Astronomy in the University of Oxford, Fellow of New College, Oxford.

[Read June 6, 1923.]

PLATES XXIX—LIII. TEXT-FIGURES 1–9.

CONTENTS.

INTRODUCTION.

THE great interest of the Fijian islands in relation to the problems of Müllerian Mimicry first attracted my attention when, in 1899, I received examples of the two commonest Euploeas from my friend Prof. Gustav Gilson, of Brussels. We had met during the meeting of the British Association in Canada in 1897, and he had then told me of his intended visit to Fiji, and kindly promised to collect butterflies for me. When, two years later the specimens arrived and were studied, it at once became evident that, of two species of *Euploea* present in the collection, one, *E. helcita eschscholtzi* (Pl. XXX, fig. 1 ♂, fig. 2 ♀), appeared obviously to have acted as the model for the other, *E. boisduvalii proserpina* (Pl. XXX, fig. 3 ♂, fig. 4 ♀). It seemed certain, from a mere inspection of the pattern, that the principal spot on the fore-wing of *proserpina* had been lengthened inwards so as to bring about a superficial resemblance to the principal spot on the fore-wing of *eschscholtzi*, and that the likeness between the two, flying together on the same island, would be extremely close. The material at hand was, however, insufficient to suggest that this likeness is, as so often in mimicry, closer in the female than the male. I was so struck with the evident change, as it appeared, produced in one species by the power of selection directed by the presence of another species in the same locality, that I asked Mr. Alfred Robinson, of the Oxford University Museum, to prepare one of his beautiful photographs of synaposematic Danainae (chiefly Euploeini) and included in it the pair of Euploeas from Fiji (to become figs. 4 and 9 of the plate mentioned below). And when my friend, and at that time pupil, Major J. C. Moulton, was writing his paper "On some of the principal Mimetic (Müllerian) Combinations of Tropical American Butterflies" (Trans. Ent. Soc. Lond., 1908, p. 585) I suggested that it would be

interesting to reproduce this photograph as Pl. XXXIV in order to show that the very same principles illustrated for the New World tropics in his Pls. XXX–XXXIII were also illustrated in the allied groups, but with totally different patterns, in the tropics of the Old World.

Major Moulton's plate XXXIV was criticised by the late Col. Manders in a letter published in "The Entomologist's Record" (vol. xxi, p. 120, 1909), in which he suggested that the S. Indian association of three common Euploeas (figs. 1–3, 6–8) was of no more significance than that of the three commonest Pierines in Middlesex.* Following his letter were some editorial comments chiefly directed to the contention that recent work on mimicry took no account of the habits and the distribution of the insects themselves.

The latter criticism hardly needed a reply, and received none at the time. It will be clear to anyone who reads what has been published on this subject in the past thirty years that great pains have been taken to stimulate observation in the field and to record the results with the most minute attention to the data of time and place. But, as regards Col. Manders' letter, the present writer exhibited sets of Euploeas from various localities and showed that their patterns, which differed as we passed from one locality to another, were, in each locality, followed by various local species. (Proc. Ent. Soc., 1909, p. xxxvii). He also showed that the recognition of Müllerian resemblance among the Euploeas was not, as had been assumed in the "Record," a new thing, but had been originally suggested by the late Prof. Meldola, F.R.S., in 1882 ("Ann. Mag. Nat. Hist.," 5th ser., vol. x, 1882, p. 417), and worked out in detail with abundant illustrations of local Euploeine and Danaine associations in the following year by the late Dr. Frederick Moore (Proc. Zool. Soc., 1883, p. 201).

The small effect produced by Dr. Moore's memoir was probably due to the unjustifiable creation of genera founded on the secondary sexual characters of the male. The extent to which these genera have been sunk may be inferred from H. Fruhstorfer's treatment of the Euploeas in Seitz's "Macro-Lepidoptera of the World" (Sect. II, Vol. ix, translated by L. B. Prout). To take but a single

* The Pierines are probably a somewhat unpalatable group, and it is by no means certain that the upper surface resemblance between the commonest Middlesex species is without bionomic significance.

instance. Fruhstorfer recognises only the single genus *Euploea*, which he divides into various groups. One of these (p. 226) is "The group of *Crastia*" and, within this, "Subgroup A.," containing Euploeas without distinctly visible sexual stripes, is held to include *eleven of Moore's genera*, viz., *Nipara, Oranasma, Patosa, Sarobia, Vadebra, Lontara, Gamatoba, Menama, Tronga, Sabanosa*, and *Adigama*. So that what one author classifies under eleven genera is classified by another as a subgroup of one of the groups into which he divides a single genus! It is possible that the future investigation of structure and life-histories may show that Fruhstorfer has gone too far in this wholesale treatment, but no one, I think, will deny that his arrangement is far truer to nature than Moore's. In the present paper it will be shown (pp. 594, 595) that the New Hebridean Euploeine—"*Mestapra*" *paykullei* Butl., of Moore's monograph (*ibid.*, p. 285), has probably interbred with the east Fijian race of "*Deragena*" *proserpina* Butl. (p. 272).

This reckless and injurious creation of genera should not, however, prevent us from giving to Moore the great credit of being the first to recognise the prevalence of local mimetic associations among both Danaini and Euploeini. In order to direct attention to this important discovery the following paragraphs are quoted from pp. 205, 206 of his memoir:—

"When studying this subfamily of Butterflies in 1879, preparatory to describing the species for my work on the Lepidoptera of Ceylon, I separated the whole of the species then in my collection into groups, according to the presence and position of the 'sexual mark' or 'scent-producing organ' in the male insect. Having thus separated the species into such groups, I was then much surprised to observe that this operation had placed before me several species in each group which bore an extraordinary resemblance, in the pattern of the markings on the wings, to certain species which I had arranged in the other groups.

"Having thus taken these 'sexual marks' or, as they are now known to be, 'scent-producing organs,' as the primary structural character for separating the species of the old genus *Danais* and *Euplœa* into minor generic groups, these assemblies of species, thus grouped, brought to my mind at once the fact that here were evident illustrations of a form of mimicry occurring between closely related groups,

and that, too, *within* a protected family of Butterflies, or, more extraordinary still, *between species of the same genera*, as it would then appear, if the species are restricted to *Danais* and *Euplœa* respectively.

"At that time I had forgotten that this phenomenon of mimicry *between related genera* had been observed by my friend Mr. Bates among the Danaoid Heliconidæ; but subsequently, on again working with his memoir in the Linnean 'Transactions' before me, I became aware of his discovery.

"This analogous form of mimicry, occurring in *Danais* and *Euplœa*, had, however, not previously been recorded. Certain species, it is true, when being described, were noted by Mr. Butler as having a resemblance to certain other isolated species.

"Since my own observations were thus made, I have had the opportunity of showing and pointing out some of these mimetic groups in *Euplœa* to my friends Mr. Bates, Mr. Meldola, Mr. Distant, and others; and these facts have since served as materials for discussion in certain recent articles on mimicry in Butterflies.*

"The extent to which this form of mimicry exists among the species of the old genera *Danais* and *Euplœa* will be better understood by an examination of the accompanying Tables of the five primary groups into which I have divided each of these old genera.

"In these Tables the names of certain genera and species in each of these five groups are given, and the names of those genera and species, *inhabiting the same locality*, which imitate them."

After naming the collections he had studied in the preparation of the Tables, which, as he states in a footnote, could have been much extended had it been possible to bring the collections together at the time when the paper was written, he continued: "This imitative character pervades all the groups into which I have divided the species hitherto arranged under *Danais* and *Euplœa*. . . ."

The study of the Tables of "Mimetic Species in Euplœina" (pp. 208–212) together with the examples in P.Z.S., 1883,

* The following references are given in Dr. Moore's paper—"W. L. Distant, Rhop. Malayana, p. 33 (1882); R. Meldola, Ann. Nat. Hist. 1882, Vol. x. p. 417; W. L. Distant, Ann. Nat. Hist. 1883, Vol. xi. p. 43. See also Wallace, 'Nature,' May 25, 1882 [xxvi, p. 86]."

Pls. XXIX and XXX, or better still with the specimens themselves, will convince any one with an open mind of the reality of the local associations discovered by Dr. Moore, and supplies the answer to criticisms brought forward more than a quarter of a century later in the "Record."

Only within the past year, when collecting records of various kinds for the present paper, I have become aware of better evidence for the reality of these local Müllerian associations than any which Moore was able to supply. The evidence is better because it rests upon observation in the field, made too in the year before the appearance of Moore's work. Writing on February 23, 1923, Mr. Gervase F. Mathew, from whom I have received much help in this work, kindly copied for me the following record:—

"In my Lepidopterist's journal (which I kept all the time I was on the Australian Station) I find in Nov. 1882, when we were at Ugi, in the Solomon Islands, the following note—'*Euplœa assimilata* Feld., *E. brenchleyi* Butl., *Danais insolata* Butl. and *Diadema* [*Hypolimnas*] *fuliginescens* Math.—These 4 species, on the wing, looked exactly alike. It was a good instance of mimicry, but which mimicked which it is difficult to say; nor could I understand the reason, for as far as my experience goes all the species of these groups require no artificial protection, as birds do not seem to touch them, nor are their larvae much attacked by ichneumons, and I have proved that they are distasteful to birds.'"

Two of the above species, *brenchleyi* and *insolata*, are quoted, of course with different generic names, in Moore's Table IA (p. 208), and *brenchleyi* again in Table V (p. 210), where it is associated with *imitata* Butler, which is doubtless the *Euploea* first mentioned by Mr. Mathew, *assimilata* being the name of an allied species from the Aru Islands. The *Hypolimnas* did not fall within the limits of the subject as treated by Moore. But we can imagine what his delight would have been to receive this evidence from the observation of living nature in support of the conclusions he had reached in the museum.

The Müllerian theory had only been published in this country in 1879 (Proc. Ent. Soc., p. xx), and any naturalist who was without this clue would have encountered the difficulty mentioned by Mr. Mathew, and felt by Bates, as we know from the thoughts expressed in his great monograph on mimicry (Trans. Linn. Soc., Vol. xxiii, p. 495, 1862).

As regards the parasitic foes referred to by Mr. Mathew, it is probable that prolonged investigation directed to this special subject would show that a comparative immunity from the attacks of vertebrates is compensated by the loss inflicted by invertebrate enemies, in accordance with the conclusions of Dr. G. D. H. Carpenter ("Report, British Association," 1913, p. 516).

A note made at the time, recording the observations of a particular day is, in some respects, even more forcible than the summing up of experiences over a longer period. On November 9, 1882, when he was at Selwyn Bay, Ugi Island, Mr. G. F. Mathew wrote in his journal:—"I noticed a very interesting example of mimicry to-day—a black *Euplœa* with broad white marginal bands was not uncommon, and, flying with it was a *Danais* with markings almost identical, and in addition to which I took a *Diadema* (*Hypolimnas*) which on the wing might have been mistaken for either of them! Which mimicked which I am at a loss to know. Also the reason of the mimicry, for all three species are, I believe, avoided by birds, both in their larval and perfect state."

I have quite recently received a letter dated October 22, 1923, giving an account of Mr. H. W. Simmonds' observation of the dominant Euploeine associations in some of the Solomon Islands. The illustrative specimens, to be shown to the Society in the near future, will throw light on the relative numbers of the associated species.

Several different Euploeine associations, together with the other butterflies which enter them, are beautifully represented in Plates I–III of "Bull. Hill Mus." (vol. i, No. 1, 1921), showing characteristic patterns of the Key, Aru, Tenimber and Fiji islands, and Australia, respectively. The resemblance in each locality, together with the difference from other localities, is here convincingly demonstrated.

Mimicry of Euploeas and Danaines by species of the genus *Hypolimnas* in many parts of the Old World is also the subject of a paper by the late Col. C. Swinhoe (Journ. Linn. Soc., Zool., xxv (1896), p. 339).

A. RECIPROCAL MIMICRY OR DIAPOSEMATIC RESEMBLANCE.

In his researches on the Pierinæ (Trans. Ent. Soc., 1894, p. 249 *; "Rep. Brit. Assoc.," 1894, p. 692) Dr. Dixey,

* See especially pp. 296–298.

F.R.S., first came across facts which suggested to him that Müllerian mimicry was sometimes brought about by the mutual approach of two species. In later investigations he considered that he found further evidence pointing in the same direction (Trans. Ent. Soc., 1896, p. 65 *; 1897 p. 317 †). In the course of the discussion which followed the last paper (Proc. Ent. Soc., 1897, pp. xx–xxxii, xxxiv–xlvii) it was suggested by the present writer (Proc. Ent. Soc., 1897, p. xxix, note) that the new terms "Synaposematic Resemblance" or "Common Warning Colours" expressed Fritz Müller's principle better than "Müllerian Mimicry," and that similarly the terms "Diaposematic Resemblance" or "Diaposematism" were advantageous alternatives to "Reciprocal Mimicry."

Later on it appeared that Fritz Müller, in a brief paper unnoticed in this country, had himself clearly stated the hypothesis of mutual approach between two species. The paper which had here been looked upon as Müller's original statement of his hypothesis ‡ appeared in "Kosmos" (May, 1879), and was immediately translated and published in our Proceedings (1879, p. xx) by the late Prof. Meldola. But in the previous year Fritz Müller had published in Carus' "Zool. Anzeiger" (I, 1878, pp. 54, 55) a brief paper, which, after the lapse of nearly forty years, was noticed in England, translated by Mr. E. A. Elliot, and printed in our Proceedings (1915, pp. xxii, xxiii). The concluding sentence states "that in all probability in many cases . . . the question which of the two species is Model, and which is Mimic, is idle; each has reaped some advantage from being like the other; they may even have gone to meet each other."

In 1908 Dr. G. A. K. Marshall, F.R.S., in an able paper (Trans. Ent. Soc., 1908, p. 93) criticised the principle of Diaposematism, objecting to the interpretations offered in the special examples and also maintaining that the numerical considerations were opposed to the conclusions.

Dr. Marshall's paper was followed by a discussion (Proc. Ent. Soc., 1908, pp. xiv–xvii) and by Dr. Dixey's paper

* See especially pp. 72–76. † See especially pp. 327–329.

‡ The "actual existence of diaposematism" is foreshadowed in this paper, although not directly stated as in the earlier, unnoticed one. On this point see Dixey in Trans. Ent. Soc., 1908, p. 583. Also, add to the above-quoted papers by him—Rep. Brit. Assoc., 1907, p. 736, and "Nature," lxxvi (1907), p. 673.

in the Transactions for 1908 (p. 559), to which Dr. Marshall replied in the Proceedings of the same year (p. lxx) and 1909 (p. xx), the last-named paper being followed by a brief discussion (pp. xxi, xxii).

These references have been given because, after the lapse of nearly fifteen years, the subject is again raised by Mr. Simmonds' discoveries in Fiji. It was well, I think, that the controversy was allowed to rest for a time during which observations could be made and recorded. In the attempt to reconstruct the changing scenes of organic evolution we require immense masses of data, and although I believe that Mr. Simmonds' material from Fiji and some of the neighbouring islands is, for this purpose, more important than any hitherto collected, yet nearly every part of the following investigation left me longing for more and still more evidence from the islands of the Pacific.

So far as the numerical argument is concerned I fear that my very non-mathematical mind is inclined to look upon it much as some of my non-scientific friends, principally ladies, look on the conclusions of Science, viz. that the safest prediction is the one that anticipates the most improbable result. Knowing full well my own weakness I asked for the help of my kind friend Prof. H. H. Turner, F.R.S., who, after reading the numerical arguments on both sides, has written the Appendix to the present paper.

B. MR. HUBERT W. SIMMONDS' OBSERVATIONS IN FIJI, WITH THE ILLUSTRATIVE MATERIAL.

Mr. Simmonds first wrote, June 7, 1919, saying that Mr. Jepson had shown him a letter I had written, asking for numbers of Fijian Euploeas, and that he had suggested to him that he might collect some for me to study. This he had done and was sending a consignment. I wish to thank both these gentlemen for enabling me to work with excellent material on a problem which had haunted me ever since the arrival of the Euploeas from Prof. Gilson, just thirty years before.

The first set of specimens received was described and tabulated in our Proceedings for 1919 (pp. lxix–lxxi). The name *Nipara eleutho* Quoy, by which the species was then known in the British Museum, has been replaced in this memoir by *Euploea helcita eschscholtzi* (see pp. 580, 581). Mr. Simmonds' material at once showed that the female

proserpina was, in average specimens, a much better mimic of *eschscholtzi* than its male, thus following the rule for mimetic species in which the sexes differ.

Another important result which became clear was the fact that the Fijian Danaine, *D.* (*T.*) *melissa neptunia* Feld. is a mimic of the Euploeas, Mr. Simmonds stating in his first letter that it "flies with the Euploeas and is very difficult to distinguish when on the wing" (*ibid.*, p. lxx).

In the following year Mr. Simmonds sent a most interesting series of *Hypolimnas bolina* from the Cook and Society Is., and Euploeas (*E. helcita walkeri* H. H. Druce) from the latter (Proceedings, 1920, pp. lxxii–lxxv). In the same year he also sent a further set of the two Euploeas and the Danaine, not only from various localities in the Fijian main island Viti Levu, but also from Ovalau and Moturiki (*ibid.*, pp. lxxx–lxxxiii). The rest of the splendid material, except for a brief account of the families of *H. bolina* bred from known female parents (*ibid.*, 1923, pp. ix–xii), has been reserved for the present paper.

When specimens began to arrive from the far eastern part of the Fijian group and from the outlying islands, such as Kandavu in the south, the extraordinary interest of Fiji as a whole became obvious to both of us; for Mr. Simmonds, in his letters, more than once pointed out that the dark Euploeas—almost or entirely patternless—were the same species as those with a pronounced white marginal pattern in the well-known islands of west Fiji.

I was naturally most anxious to study more and ever more specimens from the less-known islands, but the following extracts from Mr. Simmonds' letters will show what he went through and also the reasons why more could not be done.

November 29, 1921.—"Travel here is not too good; it is often in 15- or 20-ton cutters with no sanitary arrangements and no cabins, and Hindus, Chinese, Fijians and Whites all huddled up together, so that one naturally waits until an occasional better opportunity offers unless it becomes necessary to go on duty."

February 3, 1922.—"They have now taken off our little inter-island mail steamer. This means travel by cutters more than ever."

March 24, 1922.—"This country is most difficult to work, as there are no hotels outside the capitals, and one is dependent upon the hospitality of natives and settlers

when travelling: also for boys to carry one's baggage; and this latter is most difficult." Then, owing to the loss of the steamer, "one has to depend upon chance cutters to get from island to island. The only other way would be to make a serious expedition with a boy and take tents and all camping materials."

Again on November 5, 1922, he spoke of the difficulty of communication between the islands, and especially of reaching the outlying parts of the group.

Another disheartening thing about collecting in Fiji is the growing scarcity of butterflies in the well-known islands. At first Mr. Simmonds put this down to the big *Polistes* wasp introduced into Fiji a few years before he came there. Thus, he contrasts the collecting on the eastern islands Thithia and Vanua Balavu with that on Viti Levu:—

September 10, 1921.—"I have had a most interesting and exciting trip round the group. We visited several islands where there are no mynahs or hornets and found butterflies in abundance."

November 29, 1921.—"You have no idea how scarce butterflies are on Viti Levu, and I can only blame the introduced hornets. These latter are spreading steadily over the group.

"Round Suva one can go all day and, except *Xois sesara* or *Terias* sp., not see a butterfly."

Later on Mr. Simmonds came to doubt whether the *Polistes* was responsible. Thus, on February 3, 1922, after referring to barren days in the Upper and Lower Rewa River districts (Viti Levu), he wrote: "Butterflies seem to have become even scarcer since I came here three years ago. I do not know why. I once thought it was hornets, but they are growing scarcer now, and I think that it must be the small ants, which simply swarm."

March 24, 1922.—"I do not know what has destroyed the butterflies in Fiji, but all agree here that they were much more abundant formerly. It may be ants, I can think of nothing else except mynahs."

April 10, 1922.—"*H. bolina*, scarce three years ago on Viti Levu, is now almost non-existent. I do not think I have seen a dozen in the past six months, and it seems the same with other species. People tell me also that there were formerly far more about, even in Taveuni, where *bolina* is still in great numbers. I do not suppose they were ever so abundant in the wet areas, and last year was

exceptionally wet, as also has this been so far (nearly 80 inches in 3½ months). This may account for it. Hornets, which I formerly suspected, are undoubtedly growing fewer."

It is difficult to believe that the weather is responsible when Mr. Simmonds found the eastern islands still prolific, and we are driven to the depressing conclusion that man is responsible, either directly by the enemies he has consciously introduced, or, indirectly, by those which have followed in his wake. If this be so, we are probably witnessing a permanent change, or at any rate one that will endure for a long period, and therefore Mr. Simmonds's notes on the subject may have a historic interest which justifies the addition of the following to those which have been already quoted :—

December 16, 1922.—" So far as Suva is concerned collecting grows rapidly poorer, and it is very seldom now that I even see a specimen of *H. bolina.* Many other (in fact, most other) portions of Viti Levu are equally poor."

May 5, 1923.—" I have only seen one *H. bolina* here [nr. Suva], which I captured. . . . This gives an idea of how rare this species, formerly so abundant, has become. They tell me that they are growing scarcer on the other islands. . . .

" A walk of 10 miles in bright sunshine only showed 3 *neptunia* seen, 2 Euploeas, a few *Xois sesara* and *Zizera labradus* (?), and possibly another *H. bolina* or it may have been a *Euploea* flew past.

" I visited Moturiki and saw 2 or 3 ♀ *bolina* and brought back a large one of the Queensland type. Unfortunately it proved to be empty. This will give you a good idea of how disheartening it is trying to collect here. One goes miles and never sees a specimen."

May 23, 1923.—" The weather has been good, but I have not seen a single *H. bolina* since I last wrote."

These extracts from letters written during the past four years suggest something of the difficulties and disappointments endured by Mr. Simmonds. How much he has achieved in spite of them will, I hope, appear in the course of the present memoir. It is a great pleasure to thank him for helping me to realise a dream nearly a quarter of a century old.

C. COLLECTIONS STUDIED AND HELP RECEIVED.

I have also received much kind assistance from many scientific friends in this country and I wish to express my grateful thanks for all they have done—to Capt. N. D. Riley, for much help in the course of my work in the British Museum of Natural History, and to Mr. H. T. G. Watkins, in the work on *Hypolimnas bolina* in the same Museum; to Lord Rothschild, F.R.S., for freely lending material from the Tring Museum, and Mr. J. J. Joicey, F.L.S., that of the Hill Museum at Witley; to Dr. Karl Jordan, Ph.D., of Tring, and Mr. George Talbot, of Witley, for much assistance and advice in the systematic side of my subject; to the Royal Geographical Society, and especially to Dr. A. R. Hinks, F.R.S., for help on its geographical side.

To Commander J. J. Walker, M.A., F.L.S., and Paymaster in-Chief Gervase F. Mathew, who have such intimate and profound knowledge of the Pacific, I owe a deep debt of gratitude. Both have given me the benefit of records made forty years ago and of their memories. Commander Walker has also presented to the Hope Department his splendid collection of Danainae and of *Hypolimnas bolina* from the Pacific, and this, together with the fine collection recently presented to the Department by Rear-Admiral Edmund Bourke, has been of immense help in studying the Fijian problems.

Among the older specimens in the University Collection special mention must be made of duplicates presented by the late Dr. F. D. Godman, D.C.L., F.R.S., and Osbert Salvin, M.A., F.R.S. These include many specimens collected in Fiji by C. M. Woodford—all with excellent data. When it is remembered that in collections generally, the word "Fiji" is all that appears on the great majority of insects from this group of islands—on *all* the butterflies from these islands in the Adams and Crowley Collections in the British Museum—it will be realised that specimens from Fiji taken by Woodford, or from other parts of the Pacific by Commander Walker, are of the utmost value to one who desires to study the associations, invasions and local races in this part of the world.

In the Hope Department Dr. Eltringham, D.Sc., has, as on so many previous occasions, given me the kindest help, and I have depended upon his microscopic examination of structure to decide doubtful points of affinity.

The skilful assistance of Mr. A. H. Hamm and Mr. J. Collins, in preparing, labelling, and arranging the specimens for study and for photographing have been essential for carrying on this piece of work, and I wish to express my warm thanks to them, as also to Mr. Alfred Robinson for his care and skill in taking the photographs for all the uncoloured plates. I am very grateful to Miss O. Tassart for the great pains and interest she has taken in painting the families of *H. bolina* for the coloured plates. It was, I am aware, a great labour, but I hope that she will feel in some measure repaid by the beauty and success of the reproductions.

The possibility of obtaining a coloured plate illustrating the life-history of the Fijian *bolina* I owe to the kindness of Mr. G. F. Mathew in lending me the painting he prepared when visiting the islands in the early 'eighties of last century. I am glad to know that he is pleased with the result.

A paper of this kind which attempts to show the evolution of a pattern and in many cases the first steps which have led to its development, would be of little value without abundant illustration. And when we are trying to trace its gradual change as we pass from one island to another at no great distance, and to judge in each island of the effect produced by members of an association upon one another, it is of the utmost importance to be able to represent not selected individuals but a whole series taken at a particular time. And finally when at length a naturalist on the spot has bred from known female parents the astonishingly different female forms of the Fijian *Hypolimnas bolina*, nearly all of them described as distinct species, the full effect of this admirable investigation cannot be produced without coloured plates, showing the female parent, when possible, and an example of each female form present in her offspring.

That the Entomological Society has been enabled to publish this memoir upon organic evolution, with all these advantages, is owing to the Fund for Promoting the Study of Evolution presented to the University of Oxford by my friend Prof. James Mark Baldwin.

D. FIJI, THE GATEWAY INTO POLYNESIA.

The butterfly fauna of Polynesia includes no American species except that recent intruder *D. plexippus* which is apparently about to occupy every tropical land which

supports its food-plant. Nothing need be said of this butterfly here, as it has been so fully dealt with by Commander Walker (Ent. Mo. Mag., Vol. xxii, p. 217; l, pp. 181, 224).

The Old World affinity of the indigenous species is easily accounted for when we look, first at the wide expanse of ocean separating Eastern Polynesia from the American coast, and then at the Western Pacific and the distribution of its island groups. Innumerable stepping-stones are scattered over the track by which an entrance was effected from the nearest islands, and by which these became populated. From the east end of New Guinea the track runs north and then eastward, through New Britain and New Ireland and the small groups to the south of them, to the Solomons, and through these south-east, by way of the Sta. Cruz and Torres Islands, to the Banks Islands and New Hebrides—a huge mass of scattered islands lying due west of Fiji and stretching far to the north and south of it. Its importance is much increased by the Loyalties and New Caledonia, near at hand to the west of its southern extremity. I propose to speak of this mass as the Island Screen of the West. There can be no doubt that it was from this great multitude of islands, mostly small but rich in Austro-Malayan species, that Fiji received its butterfly fauna, and became the gateway through which Polynesia was invaded. Fiji itself cannot be regarded as oceanic, but rather as an outlying part of the Island Screen. When it is fully explored it will probably be found to support more than forty species of butterflies, a number far greater than that of any other Polynesian group.

In a study of the few Euploeas and Danaines of Polynesia and Fiji, and of their relationship to the species of the great Screen of Islands to the West, we shall find evidence of successive waves of invasion, and shall be able to infer something of the course of evolution in the areas from which the invaders came. It is, of course, very late evolution—just the last page or two of the last volume of the boundless library in which is written the history of organic change.

The conditions of life in the oceanic islands of the Pacific are not such as to lead to the preservation of ancient forms of life. The limited area and relative simplicity of the web of organic interdependence both tend to ensure the extermination of a species when unfavourable conditions arise. And these dangers are so greatly intensified in the

maximum simplicity of the low-lying coral islands and atolls that their butterfly fauna, with the exception of *Hypolimnas bolina*, is unlikely to throw much light on the problems considered in this paper. It is only from the oceanic groups which include islands with high volcanic peaks, or at least coral raised to 200 ft. or more, that illuminating material is to be expected. Such groups are the Samoan, the Friendlies (Tongatabu, etc.), Cook (Rarotonga, etc.), and Societies (Tahiti, Eimeo or Moorea, etc.). The low flat islands of the Ellice Group are important exceptions, yielding two forms of *Euploea helcita* (p. 583).

The great need for the investigation of these problems is abundant material with full and accurate data, and it is to be hoped that this memoir in which I have done my best with means, except in Fiji, wholly insufficient, will direct the attention of collectors to the want, and lead to its supply.

E. THE EUPLOEINE AND DANAINE INVASION OF FIJI AND POLYNESIA.

It will now be necessary to consider each indigenous species or island race of Euploeas and Danaines, and attempt to reconstruct its history in the immediate past—we cannot expect to reach farther back than that. In my opinion the evidence points to the conclusion that, either by replacement of species or by changes in species, the patterns of certain butterflies have been gradually reduced in the great Island Screen of the West, and that, as successive waves of invasion have proceeded eastward, some of them have carried and preserved in fresh islands the patterns which later on dwindled in the original home.

I. The Races of Euploea helcita helcita Boisd.

This butterfly is by far the most wide-ranging *Euploea* of the Pacific, its races, according to our present knowledge, extending from New Caledonia to the Society Islands. It was until recently given the name *eleutho* Quoy, in the British Museum Collection, and this determination was followed in Proc. Ent. Soc., 1919, p. lxix; 1920, p. lxxx; and Trans. Ent. Soc., 1908, p. 603. The history of the mistake has been recently published by Mr. G. Talbot in Bull. Hill Mus., vol. i, No. 1, p. 26 (1921). The species in New Caledonia and Navigators' Islands is

also correctly given as *helcita* by Moore (P. Z. S., 1883, p. 258), but erroneously as *eleutho*, in Samoa and the Ellice Is. (p. 272).

After comparing the material from the British, Tring, Hill (Witley), and Oxford Museums, I believe that the following island subspecies can be distinguished, following the principles so well and truly established by the work at Tring.

(a) *Euploea helcita helcita Boisd., of New Caledonia.*—Very close to the succeeding, but distinguished by the smaller spots of the two rows in the hind-wing, and the fact that the inner or sub-marginal row is shorter towards the anal angle; also, more obviously, by the much greater size of the principal spot of the fore-wing. The expanse of a specimen of average size is about 65·0 mm.

(b) *Euploea helcita lilybara Fruh., of the New Hebrides.*—Very close to *helcita* and also to the succeeding species. I believe that a sufficient series would show that *lilybara* is rather smaller than *helcita*, probably about 62·0 mm. on the average.

I have retained Fruhstorfer's name, but the description (Seitz, vol. ix, p. 276) of *lilybara* does not correspond with any specimen I have seen from the New Hebrides. He describes it as transitional between *eschscholtzi* and *aglaina*—a nearly black form from Tutuila (Samoa) figured on by him, Pl. 86 A. But the New Hebridean species is very close to *helcita* on the one hand and to *eschscholtzi* on the other, and the position he gives to it raises a doubt as to whether he had before him some aberration or a specimen with misplaced label. He gives the locality as Tanna, New Hebrides.

(c) *Euploea helcita eschscholtzi Feld., of the Western Fijian Islands.*—The principal spot of the fore-wing longer and narrower than in *lilybara*, and the spots of the hind-wing on the average rather more developed. Average expanse about 67·0 mm.

Many examples are figured in this memoir. See Pl. XXX, figs. 1, 2, and the race represented in these two figs. on Pls. XXXII–XXXIV, and XXXVI–XXXIX.

(d) *Euploea helcita walkeri H. H. Druce, widespread in Polynesia.*—I include under this subspecies all the Poly-

nesian *helcita* except those from the Samoan group and the Friendly Islands. I place under *walkeri* the *helcita* from the Societies, Cook Islands, Ellice Islands, Niue or Savage Island (an eastern outlier of the Friendlies), Fotuna, and Wallis Island; also from Eastern Fiji. *Walkeri* was originally described from Tahiti, and the type is in the Hill Museum. Fruhstorfer, not knowing that it had been already described, renamed it *matilica* in Seitz (ix, p. 276), as indicated by Talbot (*ibid.*, p. 29). It is a satisfaction that it should retain the name of an ex-President of our Society, Commander Walker, who has studied the Pacific so thoroughly, and generously helped the work of many naturalists with his admirably collected specimens.

E. helcita walkeri is an extraordinary butterfly, varying immensely in the different parts of its range. The typical form differs from the races of *helcita* hitherto mentioned, in the much greater size of the submarginal spots of the hind-wing. It is also rather larger, averaging about 69·0 mm. A series of 19 from Tahiti and 3 from Eimeo (Moorea) collected by Mr. Simmonds in 1920 are very constant, resembling the type from Tahiti. It also appears to be fairly constant and of the typical form on Fotuna I., as shown on Pl. XLII, figs. 13–19; but the size of the inner spots of the hind-wing are seen in figs. 13, 14, and 19 to be transitional towards *eschscholtzi*.

In other parts of the range we find extraordinary departures from the typical form in the direction of loss of pattern, many of the steps, leading finally to a patternless black butterfly, having received names. In the following order the progressive loss of pattern is from above downwards :—

1. *E. helcita walkeri* H. H. Druce—Tahiti, etc. Bull. Hill Mus., i, 1921, Pl. IV, B, fig. 2. Type ♂ in Hill Mus.
2. *E. helcita intermedia* Moore—Rarotonga (Cook Is.). Types ♂ ♀ in B.M.
3. *E. helcita distincta* Butl.—Ellice Is., Wallis I. Types ♂ ♀ (no locality), B.M.
4. *E. helcita perryi* Butl.—Niue or Savage I. P. Z. S., 1874, Pl. XLIV, fig. 1. Type ♂ in B.M.
5. *E. helcita indistincta* Moore—Rarotonga. Bull. Hill Mus., i, 1921, Pl. IV, B, fig. 3. Type ♂ in B.M.
6. *E. helcita unicolor* H. H. Druce *—Aitutaki (Cook Is.)

* A male from Aitutaki, figured in Bull. Hill Mus., i, 1921, Pl. IV, B, fig. 4, and referred to in Ent. Mo. Mag., Dec. 1890,

Bull. Hill Mus., i, 1921, Pl. IV, B, fig. 4. Type ♀ in Hill Mus.

There is a difference between the fore- and hind-wing markings which complicates the above order. No. 3 has a more reduced hind-wing, but stronger fore-wing pattern than No. 2.

If we were sure that each of these six steps in a graduated series was fairly constant in its locality then they would stand as geographical races, but it has not been proved for any of them. The most probable instance is the set of specimens shown on Pl. XLII, figs. 8–12. These were all taken together in Wallis I. by Mr. Simmonds (p. 629), and it is not unlikely that they represent a local race which seems to be *distincta*. But it will be noticed that Nos. 2, 5, and 6 are from the Cook Islands where *helcita* is extraordinarily variable, and it is probable that a long series would include examples of all the steps 1–6 and smaller steps between them. As a matter of fact a male from Aitutaki, very like No. 4, exists in the British Museum. Large collections of *helcita* from all the islands of this group would be of intense interest.

Furthermore, the two males and two females of No. 3 in the British Museum are accompanied by a female *helcita walkeri* (Rev. J. S. Whitmee), so that, unless there is an error in the labelling, *distincta* is not a local race in the Ellice Is. but a form of *walkeri*. In this, as in nearly all the islands, a long series, showing the extent of variation and the proportions of the different forms, is required.

The type of No. 4, *perryi*, is the only specimen from Savage I., and this, in such a species as *helcita*, tells us very little.

The E. Fijian *helcita* is, I think, best placed under *walkeri*, although its hind-wing pattern is often that of *eschscholtzi*. It is much the largest of the *helcita* group, an average specimen from Vanua Balavu being about 79·0 mm. in expanse, from Thithia about 76·0, Mango about 75·0. I need not describe it, as all the specimens received from Mr. Simmonds are represented very clearly

p. 320, is even more unicolorous than *unicolor*—the female type. Both specimens, with Nos. 2 and 5 in the above list, were captured by Commander Walker in the Cook Islands (Rarotonga, Apr. 28; Aitutaki, May 1, 1883; Ent. Mo. Mag., 1883–4, pp. 95, 96). The type of No. 1 was also captured by him in Tahiti. The spots in the hind-wing of the figured example of No. 1 are unusually small.

on Pls. XXXI, figs. 1, 2; XXXIX, fig. 10; XL, figs. 9–13, 15; XLI, figs. 12–15. Some account of the specimens will be found under the three islands mentioned above. I think it will be clear that when figs. 1 and 2 on Pl. XXX, viz. the male and female of *eschscholtzi* from western Fiji, are compared with figs. 1 and 2 on Pl. XXXI, viz. a male and female from Vanua Balavu in eastern Fiji, the latter represent a larger, coarser-looking butterfly, and that, although the hind-wing spots are reduced nearly to the size of *eschscholtzi*, the true affinity is with the examples with much larger spots from the same island, represented on Pl. XLI, figs. 13, 14. Figs 12 and 15 on the same plate represent the same specimens as those shown on Pl. XXXI, figs. 1 and 2. The reduction of pattern in the fore-wing of some of these east Fijian *walkeri* is clearly shown in the plates.

Dr. Eltringham has kindly examined the male armature of the following specimens of *helcita* and finds nothing to indicate specific difference:—

The *eschscholtzi* from Vanua Levu, W. Fiji, represented on Pl. XXXIV, fig. 1.

The *walkeri* from Fotuna I., represented on Pl. XLII, fig. 15.

The *walkeri*, f. *distincta*, from Wallis I., shown on Pl. XLII, fig. 10.

4. The *walkeri*, large E. Fijian form, from Vanua Balavu, shown on Pl. XLI, fig. 13.

We finally reach the forms of *helcita* found in the Samoan group and the Friendlies, and I was much surprised to find that they form two closely related races which are quite distinct from all others in Polynesia. So far as I am aware they have not before been recognised as distinct, and it is therefore necessary briefly to describe them.

All the forms of *helcita* hitherto described are butterflies of so dark a shade of brown that they would be called black by most observers. The Samoan and Tongan races are, even when quite fresh, distinctly brown, and not a very dark brown. The hind-wing under surface of the former set is also very dark, although in some races overspread in parts with a bluish-grey giving a bluish or purplish shade to the ground-colour, but not of sufficient strength or brightness to relieve the impression of darkness. In

others, again, the dark surface is overspread with, but not much brightened by, a bronzy-brown shade. In the Samoan and Tongan races the under surface is far less dark, and presents a strong contrast to those just described. This is due both to far paler brown ground and the strength of the overspreading grey, or bluish- or purplish-grey, extending from the anal angle to the base of the hind-wing, and inwards to the cell which is partially, or generally wholly, invaded. In some specimens from Tonga the effect is so pale that the contrast between background and light spots is largely obliterated, and the butterfly has a faded or washed-out appearance. In all specimens from both island groups the contrast is naturally very much less than in the other forms of *helcita*. The upper surface pattern is that of typical *walkeri*, except that the large spots of the inner series on the hind-wing are distinctly larger. The pattern is, in fact, the farthest development reached by any known form of *helcita*.

When these differences were first noticed in a good series from the Tongan and Samoan groups they seemed so remarkable that I thought that perhaps the specimens had been exposed to light and were faded. But a Hill Museum specimen and two in the Hope Department were consistent with those from Tring and dispelled this suspicion.

There are small but nearly constant differences between the Samoan and Tongan subspecies, the latter representing the stronger development of pattern.

It has been a pleasure to associate these interesting races with the names of Rear-Admiral Edmund Bourke and Paymaster-in-Chief Gervase F. Mathew, whose specimens have been before me as the descriptions were written.

(e) *Euploea helcita bourkei n. s.-sp., of the Samoan Islands.* —As compared with the succeeding race, the three large double spots of the inner series of the hind-wing in areas 1*c*, 2 and 3 (that in 1*c* being often actually divided into two) are not quite so large, and there is a more sudden break in size between them and the small spots, owing to the relatively small size of the one in area 4. In the fore-wing the two chief spots are smaller. The brown shade of the ground-colour on the upper surface is a little paler. On the under surface of the hind-wing the grey colour is more distinctly bluish or purplish and does not extend so

far towards the outer margin or so greatly diminish the contrast with the white pattern, which has therefore a less faded appearance than in *mathewi*. The expanse of an average specimen is about 67·0 mm.

Habitat: Samoan Islands.

♂ Type, in Hope Department, Oxford University Museum. One of three males collected at Apia and Tutuila by Admiral Bourke in November and December 1892.

♀ Type, in Tring Museum. One of a series (3 ♂, 4 ♀) taken by Mr. G. F. Mathew at Apia and Pango Pango, June 19–29, 1884. All bear his number "998."

One male in the Hill Museum was also taken into consideration in the above account.

It is to be noted that the form of *helcita* described by Fruhstorfer from Tutuila, Samoa (Seitz, ix, p. 235, pl. 86 A) and named by him *aglaina* has nothing to do with the Samoan subspecies *bourkei*. The figure suggests that it may be a female of *Euploea schmeltzii*, or, if it belongs to *helcita*, a dark form of *walkeri* near *indistincta* (p. 582). This latter interpretation is supported by a specimen in the British Museum—a male *walkeri*, with the hind-wing pattern of *eschscholtzi*, from Navigators' Islands * (Samoan group).

See also for this and the next subspecies, Mr. G. F. Mathew's notes on pp. 606, 607.

(f) *Euploea helcita mathewi n. s.-sp., of the Tongan Group (Friendlies).*—The characters of the Tongan race have already been given in the general account preceding the last subspecies. It is rather larger than *bourkei*, the expanse of an average specimen being about 70·0 mm.

Habitat: Tongatabu, Vavau, and Hapaii, and probably other islands of the Friendly Group.

* The possibility of erroneous labelling in "*aglaina*" and the specimen from Navigators' Islands must be taken into account. It is especially likely to occur in the collections from small thickly clustered islands, when many are visited. The British Museum specimen was received at an unknown date before the Register was started. Fruhstorfer's account of *helcita helcita* is incomprehensible to any one familiar with the New Caledonian race. He says (*ibid.*, p. 235) that it "seems to approximate very nearly to the figured *aglaina*," represented by him (pl. 86 A) as a nearly patternless form, and again, speaking of *aglaina*, that it differs from *helcita* in being *more* spotted. Yet *helcita* is, in the fore-wing, the most strongly patterned of all the races except those from Samoa and Tonga!

♂ Type, in Tring Museum. One of a series (7 ♂, 3 ♀) taken by Mr. G. F. Mathew in July 1884. For his notes on the abundance of the subspecies and its occurrence on Tongatabu (at Nukualofa) and Vavau, see p. 607.

♀ Type, in Hope Department, Oxford University Museum. One of two females taken at Hapaii (Friendlies) by Mr. W. H. Legge in August 1895.

A characteristic male, labelled Tonga, and (in error) "J. J. Walker, 1. vii. 1889," from the Hill Museum, was also before me. It is represented as "*walkeri*" in Bull. Hill Mus., i, 1921, Pl. IV, B, fig. 1, and a Tonga female on Pl. III, B, fig. 5, also as "*walkeri*."

(g) *The Invasion of Fiji and Polynesia by the Races of Euploea helcita.*—It is probable that the most highly patterned races, *bourkei* and *mathewi*, came in the earliest wave of invasion and that they represent a more fully developed pattern in the islands to the west from which they started. There is in the Hope Department a male specimen collected by Mr. W. H. Legge and labelled "Thursday Island, Torres Straits, 1896," but it so closely resembles the above two specimens from Hapaii in the Tonga group collected by the same naturalist that an error in the labelling seems probable. All three specimens were presented to the University Collection by the late Mr. R. S. Standen in 1906. But, if this specimen be dismissed, it is quite likely that others throwing light on the parent race from which the invaders came will be discovered in some locality far to the west or north-west of Fiji. The Tongan race with a slightly more developed pattern probably represents the original invader more nearly than the Samoan. It will be observed (pp. 608, 609) that the earliest invaders among the Danaine races of *melissa*, also more strongly patterned than their western representatives, are now found in the same two island groups, but in their case the Samoan form is probably the nearer of the two to the original invader.

E. helcita walkeri was probably next in order, and certainly earlier than *eschscholtzi*, which has not advanced beyond western Fiji. *Walkeri* represents a rather less-developed pattern and a much darker ground-colour on both upper and under surfaces. Where it has met with a dark patternless *Euploea* (*E. boisduvalii simmondsi*), as in Wallis I., and eastern Fiji it has, as will be shown, tended to lose

its pattern and by reciprocal mimicry the dark *Euploea* has, in varying degrees and in a varying proportion of specimens, advanced to meet it. In some other islands (Societies and Fotuna), where it is the only known *Euploea*, it retains the typical form; in others (Cook and Ellice Is.), it has lost its pattern to a varying extent, reaching the maximum reduction in the black *unicolor* of the Cook Islands. In my opinion, the most probable hypothesis is that in all the groups where it has reduced or lost its pattern, dark Euploeas exist or have recently existed; and it may well be possible to find them in some of the remote islands even if they have disappeared from others. That the change is recent is shown by the number of transitional forms, even in the Cook Islands, where the loss of pattern is carried furthest.

It is also in favour of the opinion that a dark *Euploea*, probably a form of *boisduvalii simmondsi* (p. 591), is present in the islands and has there acted as a model for *walkeri*, as it has in Wallis I. (p. 629), that Commander Walker took in Rarotonga on April 28, 1883, specimens of *Hypolimnas antilope*, a Nymphaline mimic of dark Euploeas of the *simmondsi* type. This form had been described by Godman as *H. unicolor* from New Ireland, but the male and female presented to the Hope Department resemble the darker male and the two females of *antilope* from Vanua Balavu, where their model *simmondsi* also occurs. The Commander did wonders in a single day at Aitutaki and another at Rarotonga, but the whole of the butterfly fauna cannot be exhausted in so short a time, not even by a naturalist as keen and observant as he is.

Another and a tempting explanation of the *walkeri* race is to suppose that it has resulted from interbreeding between the first invaders and the most recent, *eschscholtzi* —the former strengthening the pattern, the latter conferring the dark ground-colour of both surfaces. It would be an interesting experiment to attempt this cross, using the west Fijian and the Samoan or Tongan races. It would be difficult because of the habits in courtship, including the use of the scent-brushes by the male, but success should be attainable by the construction of a large chamber in which natural conditions could be reproduced. The great variation in size as well as pattern and the ease with which *walkeri* gains the *eschscholtzi* hind-wing

pattern in eastern Fiji are points which seem to support this suggestion, but I am inclined to think it is less probable than the hypothesis of a separate invasion.

The interpretation of the West Fijian form *eschscholtzi* as the result of the last and very recent invasion is obvious. It closely resembles the two races in the Island Screen of the West, and the little difference between them is of the usual kind, the retention by the invader of a slightly increased pattern. It will be shown on p. 612 that, in the long series of *eschscholtzi*, three specimens only, and of these each in a different West Fijian island, exhibited more or less closely the hind-wing pattern of *walkeri*. This is in striking contrast with the high proportion of East Fijian *walkeri* gaining the hind-wing pattern of *eschscholtzi*, but there is the disturbing effect of the dark *Euploea simmondsi* and two other members of the association to be taken into account in the east, for their presence may provide the explanation of the reduced pattern in the hind-wing of many examples of *walkeri*, as it, I believe, certainly accounts for the clouding over of the principal mark on the fore-wing.

The three exceptions in the west may be lingering traces of *walkeri* which have not been quite obliterated by the last invasion, or they may be the result of interbreeding with an occasional migrant from East Fiji. Their distribution in the islands is rather unfavourable to the latter view.

I must here repeat what has often been said in this memoir, that the great need is more material with full data, from as many islands as possible. With this aid I have hopes that we may be able to decide between these and other speculations, or replace them all by sounder ones.

II. Euploea boisduvalii boisduvalii Luc., and its Races in Western and Eastern Fiji (including Wallis Island).

The West Fijian race of this species, long known as *Euploea* (*Deragena* of Moore) *proserpina* Butl., is included by Fruhstorfer (*ibid.*, p. 241) under *eleutho* Quoy, a very doubtful arrangement. It is safer, until more is known about their structure, to consider these two forms distinct species, as Mr. Talbot has done (*ibid.*, p. 29). Mr. Talbot has also explained (*l.c.*) why *boisduvalii* becomes

the name of the species. In 1853 Lucas published a description, under this name, of a single male *Euploea*, labelled "Australia." Examination of this specimen in the Paris Museum proved that it was an aberration of the common Western Fijian *Euploea* named *proserpina* by Butler in 1866. The aberration must be very rare, for it has not been met with in the large amount of material studied in the preparation of this memoir. There is, however, in the British Museum an interesting female (Coll. Hewitson) in which the shape of the principal white mark on the male fore-wing is made up to the size of the larger female mark by a white extension clouded over like the whole pattern of *boisduvalii*. In making out the true synonymy of this form and also *helcita* (p. 580) Mr. Talbot states that he received help from M. F. le Cerf of the Paris Museum, to whom I also wish to express my thanks.

It is probable that *boisduvalii proserpina* is the West Fijian race of a species which includes two or three subspecies in the Island Screen of the West, and others far beyond it to the north-west. It may well happen, when the affinities of all these are made out, that *boisduvalii*, as the oldest name, will stand for the whole group. It is the rule of the game, and we must not grumble while the rule remains, but there is irony in the fact that its acceptance in this case involves the subordination of names founded on the description of adequate material with trustworthy data in favour of one founded on an aberration hitherto unique and provided with a false locality!

The object of this memoir is not systematic, but we must know where we stand with the species whose associations and invasions are studied, and therefore the systematic aspect of the subject has been considered in the first place. But, having considered it in the preceding paragraphs, I do not propose, on the present occasion, to follow it to the bitter end, and sink altogether the well-known name *proserpina*, but intend to speak of the commonest and best-known Fijian *Euploea*, not as *boisduvalii boisduvalii*, but as given below.

(a) *Euploea boisduvalii proserpina Butl., of West Fiji.*—The appearance of this subspecies with its conspicuous white marginal pattern is illustrated, first, in Pl. XXX. fig. 3 (male), and fig. 4 (female), and then abundantly in

figures, which will at once be recognised, on Plates XXXII–XXXIV, XXXVI–XXXVIII, and XLIV. In these plates the pattern of *proserpina* from the two chief islands of Fiji, and from some of the smaller islands near them, is clearly shown. It varies greatly but not locally, so far as we know, in this part of the group (see Map, Pl. XXIX). There are, however, two exceptions—the very large specimen with a greatly reduced pattern shown on Pl. XXXVI, fig. 7. This butterfly was taken in Taveuni which lies to the south-east of Vanua Levu and is the nearest of the western islands to East Fiji where the pattern is still further reduced and sometimes wanting. Furthermore, in the southern island of Kandavu, a rather remote outlier of West Fiji, the single specimen taken (Pl. XXXIX, fig. 5) has a pattern more reduced than that just referred to from Taveuni. These transitional forms lead naturally to the second subspecies.

(b) *Euploea boisduvalii simmondsi n. s.-sp., of Eastern Fiji and Wallis Island.*—The discovery of this most interesting race is entirely due to Mr. H. W. Simmonds. A detailed description is unnecessary. It is sufficient to point out that it differs from *proserpina* in the complete or nearly complete absence of pattern on the upper surface. The whole of the material is figured—three males from Vanua Balavu, on Pl. XLI, figs. 1–3; one male and another transitional to *proserpina*, from Thithia, on Pl. XL, figs. 1 and 2, respectively; two males and five females from Wallis Island (between Fiji and Samoa), on Pl. XLII, figs. 1–7. The individual differences to be observed in this series will be considered under the next heading.

Types: in the Hope Department, Oxford University Museum. From Wallis Island. Male, represented on Pl. XLII, fig. 2; female—fig. 4.

Comparison with Pls. XL and XLI will show that the males generally exhibit a trace of pattern, while Pl. XLII proves that the majority of the five females are patternless. Therefore one of the latter and a male with a slight pattern have been selected as types.

The dyslegnic female pattern is very clearly seen in Pl. XLII, figs. 6 and 7, and also the fact that the female varies more than the male, fig. 7 showing a more advanced pattern than any other example of *simmondsi* from East Fiji or Wallis I. More specimens are greatly needed,

especially females from East Fiji and long series of both sexes to show the amount of variation.

(c) *The Invasion of Fiji and Wallis Island by Euploea boisduvalii simmondsi, and the Changes it has undergone in the new Home.*—It will be remembered that it was the obviously mimetic modification in the principal spot in the fore-wing of *proserpina* that first directed my attention, in 1899, to the study of mimicry in Fiji (p. 566). The subject was untouched at the time, for no examples of mimicry from these islands are mentioned by Moore. Having concluded that the pattern of *proserpina* was a recent development in mimicry of *E. helcita* it was most inspiring to receive from Mr. Simmonds the evidence that a parent subspecies with only a trace of a pattern or with none at all exists in East Fiji—and not only this, but transitional forms bridging the gap between the two races. But if *simmondsi* be the ancestral form in Fiji, from what land did it come?

There are in the Western Island Screen three dark, patternless Euploeas diminishing in size from north to south. All three have on the male fore-wing a single brand much like that of *simmondsi*. The largest, *Euploea fraudulenta* Butl., is common in the Solomons, but spreads southward into the Torres Islands, where Commander Walker captured several specimens. To the south, in the New Hebrides, it is replaced by *E. paykullei* Butl., a much smaller species with narrower wings, dark brown in the male, much paler in the female. In both sexes the border of both wings is much lighter in tint, giving the butterfly a very characteristic appearance. It is very abundant, and I have had the opportunity of studying in Oxford a series of sixty-seven nearly all taken by Commander Walker and Mr. J. R. Baker. Finally, in the Loyalty Islands, lying west of the extreme south of the New Hebrides, *paykullei* is replaced by a species with broader wings, slightly less in expanse—*E. torvina* Butl. Its brand is somewhat smaller, and both it and *fraudulenta* differ from *paykullei* in the possession of variable traces of a marginal and submarginal white pattern on the under surface, in *torvina* sometimes upon the upper surface also.*

* The names *paykullei* and *torvina* are here employed in their usual acceptation; but an examination of the types in the British Museum shows that the use is incorrect. The type of *torvina* is a male from Aneiteum, of *paykullei* a female from the same island.

In *fraudulenta* this under surface pattern becomes stronger to the north in the Solomon Islands.

All three races enter into Müllerian association with others in their respective localities, the two northern and far more abundant Euploeas undoubtedly taking the central position. One other member of each of the two northern associations will be mentioned in later pages.

As to the affinity of these forms to each other and to the two races of the Fijian *boisduvalii*, Moore, who placed the three next to one another, in his genus *Mestapra* (*ibid.*, p. 285), included *proserpina* in his *Deragena* (p. 272), separated from *Mestapra* by many other genera. Fruhstorfer (Seitz, ix, pp. 241, 244, 245) placed *paykullei* and *torvina* as successive but distinct species, and separated both *fraudulenta* and *proserpina* from them and from each other by many intervening species. The probable affinity of *proserpina* to *paykullei* is pointed out by Talbot (*ibid.*, p. 29).

I therefore asked my kind friend Dr. Eltringham if he would help me by comparing the male armature of the following forms :—

E. fraudulenta, from Hiu I., Torres Is., Sept., 1900.

E. paykullei, from Renée R., Esp. Santo, N.H., July, 1900.

They are obviously the same subspecies and *paykullei* (1876) is therefore a synonym of *torvina* (1875). Aneiteum, although included in the Loyalty Is. on the type labels and by Moore (P.Z.S. 1883, p. 285), is the southernmost island of the New Hebrides, and *torvina torvina* becomes the name of the race from these islands, generally called *paykullei*. The Loyalty race, hitherto commonly known as *torvina*, requires a subspecific name, and, remembering the help kindly given in unravelling these tangles, I propose to call it *Euploea torvina rileyi*, n. s.-sp. Distinguished from "*paykullei*" in the text under the name "*torvina*."

Types: ♂♀: in Hope Department, Oxford University Museum. From Lifu, Loyalty Is. (1894).

It is probable that additional races of *torvina* will be recognised in the future. Aneiteum is the nearest of the New Hebrides to the Loyalties, and *torvina* in this island appears to be transitional between the race to the north and that in the Loyalties to the west. If this probability is confirmed by sufficient material from Aneiteum, then *torvina torvina* will be the name of the transitional race and the one in the more northern New Hebrides will require a new subspecific name. Similarly a single male with a very narrow fore-wing brand, in the British Museum, from New Caledonia, may indicate the existence of another race of *torvina*. But with such a variable species a large amount of material is required.

E. boisduvalii proserpina, from Viti Levu, Jan., 1920 (Pl. XXXIII, fig. 7).

E. boisduvalii proserpina, the very large specimen transitional to *simmondsi*, from Taveuni, Mar., 1922 (Pl. XXXVI, fig. 7).

E. boisduvalii simmondsi, from Vanua Balavu, Sept., 1921 (Pls. XXXI, fig. 3; XLI, fig. 1).

E. boisduvalii simmondsi, from Wallis I., May, 1922 (Pl. XLII, fig. 1).

Dr. Eltringham examined the structures and found no evidence that any of these forms belonged to distinct species. *E. torvina*, unfortunately was not among them, but there is little doubt that it belongs to the same series. We may, provisionally at least, regard them all as geographical races of one species.

It now becomes important to examine the relationship between *simmondsi* and the three Euploeas from the Island Screen.

The small brand of *simmondsi*, sometimes very small, as in Pl. XLI, fig. 1, is rather nearer to that of *torvina* than to that of the others, as also is the arrangement of discal spots on the hind-wing below. The incipient traces of a pattern in such a high proportion of *simmondsi*, and their development into the marked pattern of *proserpina* suggest affinity with both *torvina* and *fraudulenta* rather than *paykullei*. In size *simmondsi* is larger than *paykullei*, but (with exceptions) nearer to it than to *fraudulenta*. In shape the wings are broader than *paykullei*, but they vary a good deal in this respect.

In other features the influence of *paykullei* seems also to be clear. The pale margins of the two male *simmondsi* represented on Pls. XLI, fig. 1 and XLII, fig. 2, and of the females in figs. 3–5 of the latter plate, strongly suggest the characteristic border of *paykullei*, although in a diminished state. The male on Pl. XLI, fig. 3, if fresh, would probably have been even more convincing—all the more so because, like *paykullei*, the specimen is patternless.

I have already mentioned some of the points which suggest affinity with the larger species *fraudulenta*. It is strikingly supported by a single specimen, intermediate between *simmondsi* and *proserpina*, which appeared among Mr. Simmonds' captures in Taveuni. It is the huge, broad-winged butterfly represented on Pl. XXXVI, fig. 7. Its size and proportions, and, above all, the length and

form of the brand,* awaken the thought that perhaps there has been occasional interbreeding with *fraudulenta.* Another striking difference, both in breadth of fore-wing and especially in size of brand, is seen when the two *simmondsi* from Vanua Balavu on Pl. XLI, figs. 1 and 2 are compared.

How are these differences, which so strongly suggest mixed strains, to be explained? Comparatively little has been done in the experimental interbreeding between different geographical races. How fruitful such investigations may prove is seen in the intersexes of Goldschmidt. In continental areas the experiment is often performed for us by nature along the common boundary of two subspecies. And I think that here, too, the experiment has been performed by nature, although in a somewhat different manner. I suggest that Fiji has been invaded by dark subspecies of *Euploea,* now from the south, then again from the centre, occasionally from the north of the great Island Screen to the West, and that these invaders have interbred in their new home. It may be asked—"Why have they not interbred and become transitional in the Island Screen itself?" It may be so; the islands require investigation from this point of view. Again, the conditions are different. The effect of an invader reaching a flourishing and old-established community is likely to be quickly eliminated; furthermore, the intruder must compete with a vast preponderance of the indigenous race. Our present knowledge, slender as it is when compared with what remains to be known, makes it highly probable that there are slight differences in the scents produced by the brands of the different races, and that mating would tend to be preferential in the different sections of the Island Screen. Among a mixture of invaders reaching Fiji this difficulty is likely to be reduced.

Whatever be the interpretation of the mixed characters which seem to be revealed on the wings of *simmondsi,* its later history in Fiji is, I think, quite clear. In East Fiji (and in Wallis Island) it met with *helcita walkeri* and by reciprocal mimicry an incipient pattern appeared in a large proportion of its numbers, while the pattern of *walkeri* became reduced—in Wallis I., where we have a

* Not quite so long as that of three Torres Is. *fraudulenta,* but some males of the latter in the Solomon Is. have brands even smaller than this Fijian *Euploea.*

standard of comparison with Fotuna I., very greatly reduced (see Pl. XLII). In West Fiji it encountered *helcita eschscholtzi*, and under its influence developed into *proserpina*. Some reciprocal effect may perhaps be seen in the hind-wing pattern of *eschscholtzi*, which is more pronounced than that of the parent race *lilybara* in the New Hebrides.* This history will, I think, receive ample confirmation in the freely illustrated section of this memoir which deals with several islands in West Fiji. The history, however, is not quite so simple as here set forth. Two other Fijian Euploeas, *E. tulliolus forsteri*, and *E. nemertes macleayi*, enter the association in the east as well as the west, and they must have borne some part in the evolution of the eastern and western patterns. The Euploeas themselves are described below as IV and V of the present Section, and their part in the associations of each island in Section F.

III. Euploea schmeltzii H.-S., of Samoa, an Island Race of E. whitmei Butl., of the Loyalty Islands.

The Fijian Euploeas are interrupted by this butterfly because of its near affinity to *E. boisduvalii*. *Schmeltzii* and *whitmei* were placed by Moore (*ibid.*, p. 272) with *boisduvalii* in his genus *Deragena*, but he unfortunately gave the locality "Lifu" (Loyalties) as well as Samoa for the first and called the locality of the second the "Royalty Islands"!

Fruhstorfer (Seitz, ix, pp. 241, 242) considers the two forms as distinct species, following *eleutho*. He gives another example of the carelessness with which he had studied the Euploeas by writing of *E. whitmei*, "fore-wing with very short, but broad sexual stripe"—this of a butterfly with one of the narrowest brands to be found in the Euploeas!

* The suggestion of possible reciprocal effect in this case requires some explanation. The fore-wing of *proserpina* having gained a pattern in mimicry of *eschscholtzi* a correlated hind-wing pattern has also developed and been carried further than that of the model, which, in view of the abundance of *proserpina*, may perhaps have been affected. Two other possible influences must, however, be taken into account—(1) inheritance from the invading ancestor of *eschscholtzi*, (2) the swamping effect of successive waves of invasion from the west. It will be understood, I trust, that these are only hypothetical suggestions which may stimulate the collection of further evidence.

The extremely narrow brand in both *schmeltzii* and *whitmei*, together with the shape of the fore-wing, rendered it almost certain that they were distinct from other known Euploeas in the area we are considering. Dr. Eltringham made a structural examination and found the armature different from that of the previous series (p. 594), and the two to be mentioned later (pp. 600, 603). On the other hand, he could detect no significant difference between them. They become, departing from Fruhstorfer's arrangement, two subspecies of the one with the older name, which is unfortunately *schmeltzii* (1869), so that the parent race *E. schmeltzii whitmei* (1877) becomes a subspecies of its island daughter *E. schmeltzii schmeltzii!*

The two races are apparently neither of them abundant, and we know too little about them to speak with confidence as to their part in the local associations. In Samoa it seems likely that *schmeltzii* is an isolated form; in the Loyalties *whitmei* probably enters an association with *torvina*.

It seems at first sight surprising that these two peculiar little Euploeas, so closely related and so different from all others, should be so widely separated geographically. But how little we know of the area between West Fiji and Samoa, and how much has been learnt by Mr. Simmonds' visits to three out of all the islands of East Fiji and by his day or two at Wallis and Fotuna Is. The numerous islands between Fiji and Samoa are in large part volcanic, with high elevations, and are likely to support many species of butterflies. Among them links between these two not very different races will probably be found, together with others of much greater interest.

IV. Euploea tulliolus forsteri Feld., and its Race protoforsteri n. s.-sp., in West and East Fiji.

This species and the next, for both of which Fruhstorfer's names are provisionally adopted, belong to a section of the Euploeas very different from that of the species hitherto considered. The male may bear no scent-brand on the upper surface of the fore-wing, or one of a very different kind from that of the preceding species; but, in addition, a scent-producing apparatus is developed along the border of the hind-wing which is overlapped by the fore-wing. The overlapping edge of the fore-wing is widened to form

a cover,* doubtless of value in preventing loss of the scent. It therefore follows that the fore-wing of the female has an entirely different shape, being straight where the male's is strongly curved, as may at once be seen when figs. 5 and 7 (males) on Plates XXX and XXXI are compared with 6 and 8 (females). Furthermore, in his investigation of the genital armature, Dr. Eltringham discovered an accessory pair of scent-brushes in addition to the usual pair. This fact was already known (Seitz, ix, p. 261) in the group often called "*Salpinx*" (which includes *macleayi*, to be next discussed), but is, so far as I am aware, new for the species, such as *forsteri*, often united under "*Calliploea.*"

To found a genus on secondary sexual characters applicable to a single sex is, I believe, wrong, but when they are as distinct and peculiar as they are in these two species and their allies, it seems probable that good generic characters will ultimately be found.

E. tulliolus forsteri was placed by Moore in the genus *Calliploea* (*ibid.*, p. 296), as a species next to *adyte* Boisd., from New Caledonia and the Loyalties. Fruhstorfer (Seitz, ix, p. 254) considered *forsteri* as a race of the Australian *tulliolus* F., and *adyte* as an allied but distinct species.

Although, as will be seen from Pls. XXX and XXXI, figs. 5, 6, and others which will be recognised as similar on Plates XXXII, XXXIII, XXXV (all figs.), XXXVI, XXXVII, and XXXIX—XLI, I have had the opportunity of studying a splendid series of the Fijian races, I have not been so fortunate in the parent islands to the west. But comparison with the other Fijian and Polynesian Euploeas renders it almost certain that the invasion started from the same source, and, if so, the invader may well be, as Fruhstorfer believes, a race of the Australian *tulliolus* which reached first the Island Screen of the West and then Fiji.

In Fiji we may distinguish between the eastern and western races by the comparatively strong development of pattern in the latter. On the other hand, in East Fiji the pattern may even be wanting, as in the male from Mango represented on Pl. XXXIX, fig. 12. In Fiji as a whole there is complete transition from one form to the other,

* A patch of scent-scales is also apparently present on the under surface of the overlapping fore-wing. The structures in this group of Euploeas are an inviting subject for microscopic investigation and their use for observation in the field.

but nevertheless a great difference between East and West Fiji. However, the transition is so gradual and the proportion of exceptions, especially in the east, so high, that I have figured nearly every specimen received from Mr. Simmonds.

The question arises—" Did Felder describe *forsteri* from a specimen with a well-developed or a reduced pattern ? " Formerly in the British Museum Collection the latter alternative was adopted and the western race labelled as undescribed; but Capt. Riley agrees with me that Felder's description makes it certain that he had before him a common example of the west Fijian race. Dr. Jordan has kindly compared a male specimen from the Felder Collection in the Tring Museum with a good photograph of the specimens represented on Pl. XXXV, and he informs me that the pattern corresponds with that of fig. 12, all the spots being blue with white centres, but with very few white scales on the third from below (posterior angle). Three of the apical spots are confluent. The hind-wing upper surface is spotless. This specimen evidently agrees with Felder's description which applies to the well-patterned race of West Fiji. The race from some of the islands of East Fiji is undescribed.

Euploea tulliolus protoforsteri n. s.-sp. This name is proposed for the race without a pattern on the upper surface of the fore-wing, or those with relatively small submarginal spots, at least one of which is either wanting or entirely blue. This latter appearance is, in my experience, only seen when the series is made up of small spots. If the whiteness of any spot requires a lens for its certain detection it will be best to consider the specimen as transitional. The spot which first becomes entirely blue or soonest disappears is probably always the third from the double spot nearest to the posterior angle of the wing. The under surface generally follows the upper and may become, like it, entirely spotless.

E. t. protoforsteri may occur as a form and not as a race in some of the islands of West Fiji. Thus in the long series from Vanua Levu represented on Pl. XXXV, three males (figs. 13–15) and one female (fig. 21) are *protoforsteri*. From this plate the completeness of the transition and the difficulty in making a dividing line will be apparent. In three islands of East Fiji—Thithia, Mango, and Vanua

Balavu—*protoforsteri* exists as a race, *forsteri* appearing as a form in the single female from Thithia (Pl. XL, fig. 8). The distinction is very difficult and often impossible to draw in figures prepared from photographs, because of the high actinic quality of the blue. Exceptions among the islands of West Fiji, in which almost all the specimens are *forsteri*, are Taveuni and the Yasawa group, where the only forms captured are near the border line. The specimens from Mango in the British Museum are consistent with those sent by Mr. Simmonds (Pl. XXXIX, figs. 12–18) and like them are *protoforsteri*.

♂ Type: in Hope Department. Mango. Captured December 8, 1921, by H. W. Simmonds. A specimen with very small blue spots (Pl. XXXIX, fig. 13).

♀ Type: in Brit. Mus. Mango. A spotless specimen corresponding to the male shown on Pl. XXXIX, fig. 12.

Dr. Eltringham compared the armature of the male *forsteri* from Viti Levu represented on Pl. XXXIII, fig. 13, with that of the *protoforsteri* from Mango, on Pl. XXXIX, fig. 12, finding nothing to suggest specific difference. It will be observed that an extreme form of the latter was chosen, and a well-marked although not extreme example of the former.

It will have been inferred (p. 598) that there is little that is decisive to be said about the original invader. The forms allied to *forsteri* are so extremely similar and their simple patterns so variable that a detailed and systematic examination of the male armature is essential for the trustworthy determination of the specific limits. I think it is probable, however, that future work of this kind, together with further collections from the great Island Screen to the West, will enable us to identify with certainty the form representing the original invader.

It is likely that the immediate ancestor of *forsteri* exists in a *Euploea* from the Loyalties, of which there are three males and four females labelled *seriata* H.-S., in the British Museum. They resemble the *protoforsteri* from Mango, but are smaller, with less of the iridescent blue over the wing surface, and the minute submarginal spots of the fore-wing rather whiter, in this and other respects being very like a single male in the same collection from the isolated Fijian island Moala (p. 623). This suggestion accords well with Moore's arrangement, for he places *seriata* immediately before *adyte*, and *forsteri* immediately

after it (P.Z.S., 1883, pp. 295–6). It accords too with Fruhstorfer, who also places *seriata* next *adyte* and considers that the two should perhaps be united (Seitz, ix, 254).

Whatever be the form which now represents the original invader, there is no doubt about the course of evolution after the entrance into Fiji. The intruders took their place in the two Euploeine associations of West and East Fiji, contrasted in plates XXX and XXXI respectively. It is far more probable that change proceeded, as it did in *boisduvalii*, in the direction of an increasing pattern than towards its reduction, and for this reason I have suggested the name *protoforsteri* for the less patterned or patternless eastern forms.

V. Euploea nemertes macleayi Feld.; its Origin and the Changes it has undergone in Fiji.

The general characteristics of the male scent-producing structures have been mentioned under the preceding species. *Macleayi* is placed by Moore in the genus *Salpinx*, following *perdita* Butl. from New Britain, which itself follows *consanguinea* * Butl., *graeffiana* H.-S., and *iphianassa* Butl., all from the New Hebrides (P.Z.S., 1883, p. 303). Fruhstorfer includes it in an immense series of subspecies under *E. nemertes* Hbn., from the southern Moluccas, placing it next to *iphianassa* and *graeffiana* (Seitz, ix, p. 266).

In the fine collections made in the New Hebrides by Commander Walker and Mr. J. R. Baker, with a few additional specimens previously in the Hope Department, I find thirty-five examples of *graeffiana* from the same islands as the sixty-seven *paykullei* (p. 592), and evidently entering into association with these latter, the males of both species being very dark brown with paler borders, the females of both a much lighter brown with borders paler still. Accompanying the form of *fraudulenta* and taken with it in the Torres Islands by Commander Walker are six males and two females of a much larger species, considered, when compared with the British Museum series, to be a form of *iphianassa*. It is darker than *graeffiana*, without the pale borders, and evidently enters into an association centred by the *fraudulenta* in the same islands. That the

* Now placed as a form of *iphianassa* in the British Museum Collection.

two Euploeas fly together is proved by the fact that four males of *iphianassa*, and three males and two females of *fraudulenta* were taken by the Commander between 6.0 and 8.0 a.m., September 14, 1900, in Hiu island.*

When a good series of the Fijian *macleayi* is compared with these species from the Island Screen in the West there can be no doubt that the great majority of the specimens resemble, both in size, tint and pattern, the form from the Torres Islands. It will be observed, however, that among the figures of *macleayi* taken by Mr. Simmonds (Pls. XXX, XXXI, figs. 7, 8; XXXVII, figs. 6–13; XXXIX, figs. 6–8; XL, figs. 3, 4; XLI, fig. 11) there is great variation in size, and also that some examples have pale borders to the wings, *e. g.* on Pl. XXXVII, figs. 11, 12, 13, the last figure representing a very pale- almost white-bordered butterfly. In Mr. Simmonds' series such specimens are females, but there is a white-bordered male in the British Museum (p. 621). It also seems to be the fact, but confirmation by much larger numbers is required, that these pale-bordered exceptions occur among the smaller specimens. It is difficult to resist this conclusion when figs. 11–13 on Pl. XXXVII, and fig. 8 on XXXIX are compared with the other representations of *macleayi* on the same plates. No one can suppose that the large and small forms or the dark and the pale-bordered, on the same small island, such as Ovalau (Pl. XXXVII: see also p. 615), are anything but an interbreeding community, and I am therefore led to conclude that the history of *macleayi* resembles that of *simmondsi* (p. 592)—that Fiji has been invaded by *iphianassa* and also by the smaller, paler *graeffiana* and that inheritance from the latter has given us the small, pale-bordered specimens.

* Commander Walker was referring to this capture when he wrote:—"Two species of that genus so characteristic of these islands, *Euploea*, were very common close to the beach" (Ent. Monthly Mag., 1902, vol. xxxviii, p. 203). The precise locality was Picot Bay in Hiu, the northernmost of the Torres Is. The date is accidentally given as Sept. 13, instead of 14.

Commander Walker also took a *Euploea* which I cannot distinguish from *iphianassa* further south in the New Hebrides and New Caledonia. It appears to be rare, but its occurence with *graeffiana* suggests that they may be distinct species, although no structural difference could be detected (p. 603). It has already been shown (p. 601) that Moore gives the New Hebrides as the only locality of *iphianassa*.

The conclusion thus reached made it important to examine the genital armature in order to discover whether there was anything to suggest specific distinction. Dr. Eltringham has kindly studied the following examples of the two forms from the Island Screen and from East and West Fiji, without finding any such indication :—

Euploea iphianassa : Torres Is., Hiu I. : Sept. 14, 1900. J. J. Walker.

Euploea graeffiana : New Hebrides, Epi (Api) I., Ringdove Bay : July, 1900. J. J. Walker.

Euploea macleayi : E. Fiji, Vanua Balavu : Dec. 9, 1921. H. W. Simmonds (Pls. XXXI, fig. 7; XLI, fig. 11).

Euploea macleayi : W. Fiji, Ovalau : Apr. 28, 1922. H. W. Simmonds. (Pl. XXXVII, fig. 7.)

If the hypothesis concerning the origin of *boisduvalii simmondsi* and *nemertes macleayi* be confirmed it will follow that Fiji has been invaded by two members of the *fraudulenta*-centred, and two of the *paykullei*-centred association, that, in Fiji, the central member of one has interbred with the central member of the other, and, with probably a further accession (*torvina*), has become one mixed race, that the two outlying members have also fused into a mixed race, finally, that the two mixed races have formed, together and with other Euploeas, associations differing in East and West Fiji.

The subsequent history in the islands is almost exactly like that of *forsteri*. *Macleayi*, with reduced pattern, enters the darker association of East Fiji, with increased pattern that of West Fiji. Here it is difficult to determine whether the East is ancestral to the West or *vice versa*; for both *iphianassa* and *graeffiana* possess a submarginal pattern. It may be that in a small island with a single Euploeine association certain forms of selection operate more quickly and completely than in a larger one.*

* Some support to the conclusion that selection may act more powerfully in small islands is perhaps to be found in the especially strong development in the opposite direction, viz. towards emphasis of pattern, in the small island of Ovalau (p. 615). By "certain forms of selection" I mean selection as brought about by the attacks of certain enemies under particularly favourable or peculiar conditions, such as the existence of a single synaposematic association in a small island in place of several in larger areas. The conclusion that there has been an exceptional development of mimicry among the butterflies of certain small islands was suggested by the remarkable examples in Bourbon and Mauritius (Proc. Ent. Soc., 1908, pp. iv–vii.)

If so we should be able to understand the reduction of pattern in East Fiji beyond the point attained in the Island Screen to the West.

VI. The three Allied Races of Danaine Butterflies in Fiji and Polynesia, and their Origin.

(a) *Danaida melissa melittula* * *H.-S., of Samoa.*

(b) *Danaida melissa angustata Moore, of the Tongan Islands (Friendlies).*

(c) *Danaida melissa neptunia Feld., and protoneptunia n. f., of Fiji.*

It will be convenient to discuss these closely allied races together. All three are placed with others, by Fruhstorfer, as subspecies of *Danaida melissa* Cram., from Java (Seitz, ix, p. 203). Moore, on the other hand, considers them as three different species of his genus *Tirumala*, placing them far apart from *melissa*, and (with *obscurata* and *moderata*) immediately following the Australian *hamata* McLeay (P.Z.S., 1883, pp. 232–3). In examining the relationship between these races, as I believe them to be, and their past history, it will be necessary to consider two others—obviously closely allied and so considered by both Moore and Fruhstorfer—*D. melissa moderata* Butl., of the New Hebrides, and, very briefly, *D. obscurata* Butl., from the Solomon Islands.

These five races are the only Danaine butterflies considered in this paper. I have already referred to the recent intruder *plexippus* (pp. 578, 579), and the only other form at present known is *Danaida petilia* Stoll, the race of *D. chrysippus* L. (or perhaps a distinct species), inhabiting Australia, the southern and eastern islands of the Malay Archipelago and the chain of island groups extending S.E. from New Guinea. It clearly entered Fiji by way of the Island Screen. Apparently it is uncommon and does not enter into mimetic relationship with any Fijian butterfly.

Fruhstorfer falls into error in his statements (*ibid.*, p. 203)

* The small size of this butterfly, as indicated by its name, is not considered in the present memoir; but it is very marked and shared by the Samoan Nymphaline *Hypolimnas bolina*. After comparing both butterflies with those of other Pacific islands, it appeared probable that a small size may have been mechanically selected in those island groups which lie in the track of Pacific hurricanes. The subject is at any rate worth a systematic enquiry, and I hope to be able to pursue it at no distant date, with the kind help of a skilled meteorologist.

about the relationship between the markings of some of the five races. Thus, he says of the Tongan species *angustata* that it "has even narrower white bands and more extended brown areas than *neptunia*." The reverse is true; the pattern of *neptunia* is far more reduced than that of *angustata*. As Mr. G. F. Mathew correctly stated in his journal, *angustata* is "intermediate between the Samoan and Fijian" Danaines (p. 607), *i. e.* it is on the whole less patterned than *melittula* and a great deal more so than *neptunia*. *D. obscurata* Fruhstorfer suggests may be synonymous with the Samoan *melittula*. It is certainly allied and may probably represent the parent race, but its present locality is the Solomon group. Fruhstorfer, in writing of it as Samoan, has been misled by Butler, who in the original description (P.Z.S., 1874, p. 275) gives "Upolu" (Samoan Is.) as the locality. Moore combines Upolu with the Solomons (P.Z.S., 1883, p. 233), in this following the labels on the type specimen. Capt. Riley has kindly looked up the British Museum Register and writes:—

"The type of *Tirumala obscurata* Butler came from the Solomons, not from Samoa. The entry is perfectly clear in the Register on this point, and the specimen has been labelled Solomons and a note added that 'Upolu,' which it also bears, is wrong."

Of the four Western Pacific races, the Samoan *melittula* and the Tongan *angustata*, with strongly developed patterns, are evidently very closely allied, as are the New Hebridean *moderata* and the Fijian *neptunia*, with greatly reduced patterns. The main difference between the first-named pair is that the pattern is more fully developed in the fore-wing of *melittula* and in the hind-wing of *angustata*. *Obscurata* is characterised by a peculiar and conspicuous hook-like fusion of markings within the inner margin of the fore-wing, a feature closely resembled by many specimens of *melittula* and approached by many others.

As regards the second pair, *neptunia* is clearly a modified form of *moderata* or some closely similar ancestor of *moderata*. The latter is a dark form with reduced markings. In Fiji the markings of the great majority of specimens have become much further reduced * and the ground-colour blacker, in mimicry of the dark Euploeas with a

* In the minority, however, the pattern is slightly stronger than in *moderata* (p. 608), suggesting that the latter at the time of the invasion was itself rather more strongly marked.

white marginal pattern. Looking at a series of the four subspecies, the dark ground-colour of the two latter and the predominant blackness of *neptunia* become obvious.

The question naturally arises—"If *neptunia* mimics Euploeas in Fiji why does not *melittula* do the same in Samoa and *angustata* in Tongatabu?" The answer seems clear, at any rate in Samoa. The ancestral form which entered Fiji (*moderata*) was already sufficiently dark, even though it may have been a little lighter than its present form, to provide a starting-point from which selection could proceed. Furthermore, and perhaps of even greater importance, the resemblance was favoured by the relative abundance of the Euploeine models. In Samoa the conditions are very different, as proved by the following notes on *melittula* and other Samoan butterflies which Mr. Gervase F. Mathew has kindly extracted from his journal written when he visited the islands in 1884, being at Apia, June 19–24, and Pango Pango, Tutuila, June 25–29. He also informs me that his memory coincides with the impression created by his record at the time.

"*June* 20.—A *Danais* [*melittula*], coming near *limniace*, but much prettier, was very abundant, and I took a good series.

"*June* 22.—The *Danais* like *limniace*, was very plentiful, and is a beautiful object on the wing. Masses of white flowers (*Sida rhombifolia*, var. ?), were growing by the sides of the paths, and in open places in the forest, and were very attractive to butterflies, and these pretty Danaids were quite the most numerous species present. It is by far the most common butterfly at Apia.

"*June* 23.—Took a number of the local Danaid.

"We left Apia on June 24th, and arrived at Pango Pango harbour, Tutuila Island, Samoa, the next day.

"*June* 25th.—It poured with rain all the morning, but cleared up a little during the afternoon, so I landed after lunch at the village of Tonga Tonga, and walked from thence to Pango Pango harbour, about a mile, along a path through the bush. It was raining off and on most of the time, but notwithstanding this there were a good many butterflies on the wing—*Euploea* [*helicita bourkei* and *schmeltzii*], *Danais*, *Lycaenae*, etc., etc."

"*June* 26.—The next day was very bright and warm and I had a long day on shore. The *Danais* was just as numerous at Pango Pango as at Apia."

In the Friendly Islands the Danaine *angustata* was evidently much less common. Mr. Mathew wrote on July 9, 1884, when he was at Nukualofa, Tongatabu:—

"Took 4 specimens of a *Danais* which seems to be intermediate between the Samoan and Fijian *limniace* [*neptunia*]. It is probably only a local variety. In one place this evening a vast number of the local *Euploea* [*helcita mathewi*] had congregated for the night among the boughs of a large tree, and a stone thrown into the tree dislodged them in hundreds. They associated with a few *D. limniace* and *D. erippus* [*plexippus*]. The Nukualofa *Euploea* was also common on Vavau island—of the same group—on July 16th, 1884."

Mr. Mathew also recorded of the Fijian *neptunia*, when he was at Suva and Levuka, June 2–11, 1884, that "they were fond of 'roosting,' in little companies, upon dead branches."

The proportions of *helcita mathewi* (p. 586) and *angustata* in the Friendlies appear to be such as would encourage mimicry by the Danaine, and it is possible that the reduction of the fore-wing pattern of *angustata*, which is especially marked in the basal half, is a slight step in this direction. We require evidence, such as Mr. Simmonds has supplied in Fiji (p. 574), that there is some superficial resemblance between the two when on the wing.

There can be no doubt that the Fijian *neptunia* is a modified form of *moderata*, the race which now inhabits the New Hebrides, but, as has been already suggested, there is reason to believe that it was somewhat less dark at the time when it entered Fiji, and that the pattern of the original invader still persists as a form in West Fiji and perhaps as a race in some of the eastern islands. This ancestral form is represented in this memoir on Pl. XLIII, figs. 1–3, and it is very different from *neptunia* as described by Felder in Reise Nov., Lep. II, p. 349 (1867), and figured on *his* Pl. XLIII, fig. 1. He there describes and figures a butterfly with a fore-wing resembling the specimen I have represented in fig. 7 and a hind-wing rather more strongly patterned than is usual with so dark a fore-wing. Its pattern is about the same as that of fig. 4—in some respects a little more, in others a little less developed. The changes in the fore-wing have apparently led the way in the mimicry of the white-patterned Euploeas, and it will be reasonable to apply Felder's name to the form represented in figs. 7–9.

I propose for that shown in figs. 1–3 the form name, and it may be the race name, *protoneptunia*. Figs. 4–6 are transitional forms linking the two extremes.

Danaida melissa neptunia, n.f., protoneptunia.—This form differs from *neptunia* in the presence of a well-developed pattern on the inner half of the fore-wing and of a more strongly developed pattern on the hind-wing. It closely resembles *moderata*, but, when many specimens of the two are compared, the following differences will be found to hold :—

(1) The proportions of the mark, inadequately described by Fruhstorfer (in Seitz, ix, p. 203) as "roundish" ("die rundliche Makel vor dem Zellapex"), towards the outer end of the fore-wing cell. This mark is like nothing so much as a child's drawing of the head, neck, and upper part of the body of a bird seen from the side and it may therefore be conveniently called the "aviform mark." In *moderata* it is slenderer than in *protoneptunia*.

(2) This comparison holds for the markings as a whole, especially in the distal half of the fore-wing;—they are slenderer in *moderata* than in *protoneptunia*.

(3) The ground-colour is blacker on both the upper and under surface of *protoneptunia*. The under surface of *moderata* is more uniform in tint and brownish.

(4) *Protoneptunia* is a little larger than *moderata*.

Type ♂: in Hope Dep., Oxford University Museum. From Taveuni, Fiji, Dec. 20, 1921. H. W. Simmonds (Pl. XLIII, fig. 1).

Type ♀: in Zoological Museum, Tring. From Suva, Nov. 1894: Wet Season. Woodford. (No. 1, Table B., p. 633).

The proportions of the different forms of *neptunia* in various Fijian islands are considered in detail in later pages (pp. 630-639), but it may be here mentioned that all the specimens in Section I of the Tables are *protoneptunia*, all in Sections IA and II—intermediates, and all in III—*neptunia*; further, that the final analysis (p. 639) supports the probability that *protoneptunia* exists as a subspecies in some of the islands of East Fiji.

It is probable that the history of these three Pacific Danaines is nearly the same as that of *Euploea helcita bourkei, mathewi*, and *eschscholtzi*. In the more remote Samoan and Tongan islands are preserved the stronger

patterns which have now disappeared from the Island Screen in the West. The stronger of the two is found in Samoa, the weaker in Tonga, thus reversing the relationship of *bourkei* and *mathewi*. In *obscurata* of the Solomons we have probably a near approach to that of the parent race, at any rate of *melittula*. *Angustata* may be the result of a later invasion by a parent race with reduced pattern, or it may have been reduced in the Tongan Group in incipient mimicry of *Euploea helcita mathewi*. Finally, in Fiji there is the interesting occurrence of two forms transitional into each other—*protoneptunia* nearly representing the parent *moderata* of the New Hebrides but at a slightly earlier stage with a slightly more developed pattern, and *neptunia* evolved in Fiji as an outlying mimic of the great Euploeine association.

F. THE EUPLOEINE ASSOCIATIONS, SO FAR AS THEY ARE KNOWN, IN THE ISLANDS OF WEST AND EAST FIJI AND WALLIS ISLAND.

The islands from which Mr. H. W. Simmonds has sent this most interesting material are here arranged from West to East, nearly following the order of the plates, and, as in these, beginning in each island with the central member or primary model. This in West Fiji is *Euploea helcita eschscholtzi*, in East Fiji *Euploea boisduvalii simmondsi* followed by the other members of the dark-winged association, and finally by *helcita walkeri*. In Plates XXX and XXXI, however, which are intended to show at a glance the difference between the two associations, the same order, that of West Fiji, is followed in both, to facilitate comparison.

It should be remembered that the Euploeine associations have attracted to them the Fijian Danaine *neptunia*, considered in Section G.

In all but the best-known islands the whole of the Euploeas received are figured. The differences being often small and the transition from one pattern to the other often complete, it has been thought well to represent as many specimens as possible, and, in the account of each island, to incorporate the results of an examination of other collections.

These Fijian associations have no striking patterns like those observed by Mr. G. F. Mathew (pp. 570-571) or

represented in Mr. Talbot's beautiful figures to which I have already referred (Bull. Hill Mus., Vol. i, Pls. I, II). But they are, as illustrated by this splendid material, the most interesting of all, because in them we get nearer than we do in any others to the actual process of evolution. The associations as a whole or some of the members are preserved in various islands at various stages of change, and what we have learnt from the material here illustrated encourages the hope that far more will be learnt in the future.

I am anxious to guard against an interpretation which may be put upon the facts recorded and the inferences drawn in the present paper. A form which develops into another is of course ancestral in time relatively to its descendant, but by no means necessarily ancestral in evolutionary progress. Organic evolution has probably never been a continuous ascent but a climb of endless ups and downs, only known to lead upward when averaged over long periods. And this is especially true of such fleeting features as colour and pattern. Some of the island forms here considered, have, I believe, been descended from ancestors with more developed patterns, some from ancestors with less. Increase and reduction of pattern have, I doubt not, succeeded each other again and again in the past, especially in the members of distasteful associations, as changes of distribution have brought them into contact now with this predominant species or combination, now with that. There is nothing in the facts here recorded to justify the inference that we are witnessing the evolutionary origin or progressive growth of any type of pattern, or its evolutionary decline, but we have strong proofs as to the course taken in particular phases of evolution.

Mr. F. Allen of the Royal Geographical Society has kindly sent me the following notes on the spelling and pronunciation of Fijian names by Mr. Reynolds of the Permanent Committee on Geographical Names :—

" Spellings should be either phonetic or the conventional Fijian, in which b = mb, d = nd, g = ng, c = th (as in *this*), q = ng-g.

" *Phonetic.*	*Fijian.*
Thithia	Cicia
Mango	Mago
Mbalavu	Balavu
Kandavu	Kadavu

"The P.C.G.N. has not yet determined which to use. The Admiralty and the 6-miles-to-an-inch map use the phonetic. The Colonial Office is inconsistent.

"Motoriki should be Moturiki (all authorities).

"Waisala " " Waialailai (all authorities)."

I. The Islands of West Fiji.

The Euploeine associations in the main islands of this western group will be found to be strongly patterned, but there are slight differences in the level reached in the different islands. There are indications that the extreme western Yasawa group is at a rather lower level of development, while specimens from Taveuni, nearest to East Fiji, and the remote southern Kandavu, are clearly transitional to the more ancestral eastern association.

(a) The Yasawa Group.

(Plate XXXII, figs. 1–13).

Mr. Simmonds paid a short visit to some of the small westernmost islands of Fiji in October 1921. Three out of the four Fijian species of *Euploea* were taken, the absentee being *E. nemertes macleayi.* Altogether four *E. helcita eschscholtzi*, three *E. boisduvalii proserpina* and five *E. tulliolus forsteri* or *protoforsteri* were received, together with a single Danaine transitional between *protoneptunia* and *neptunia.* All are represented on the plate, which clearly shows the captures effected on the separate islands, Waisala, Naviti, Yasawa and Kowata.

The specimens are, as a whole, typical western forms with a well-developed marginal pattern. The Danaine (fig. 10) is No. 11 in Table A (p. 632), and thus fairly advanced in mimicry of the West Fijian type of Euploeas, resembling in this respect the specimen represented on Pl. XLIII, fig. 5. The *forsteri* are all on the border-line between this form and *protoforsteri;* in fact figs. 5 and 12 represent the latter. It is interesting to find that these outlying western islands are in this respect not far advanced towards the western type of pattern, but more specimens are required, especially of *nemertes macleayi*, which I expect is at about the same stage of evolution as *forsteri.*

(*b*) Viti Levu.

(Plates XXXII, figs. 14–25; XXXIII; XLIII, figs. 7, 9; XLIV, figs. 5–7.)

It is unnecessary to add much to the evidence already made known that the two principal Euploeas of the chief Fijian island are of the western type with pronounced white patterns. The examples of *eschscholtzi* and *proserpina* figured in this paper, together with many others of the same two species, captured together in various localities in Viti Levu, are quoted with full data in Proc. Ent. Soc. (1919, pp. lxx, lxxi; 1920, pp. lxxxi,* lxxxii). Then there is the original publication of this example of mimicry by Major J. C. Moulton in Trans. Ent. Soc. (1908, p. 603, Pl. XXXIV, figs. 4, 9). Of the large proportion of specimens in museums unfortunately labelled "Fiji" without further details, the great majority probably came from the neighbourhood of Suva and most of the others from Levuka in Ovalau, an island near Viti Levu, and with the same type of pattern.

Euploea helcita eschscholtzi.—Out of the large number of *eschscholtzi* kindly sent to me from the western islands by Mr. Simmonds only three specimens show an approach to the *walkeri* race, with a much broader submarginal band to the hind-wing, although this is the predominant form in Eastern Fiji so far as we know it. The first to be received was a male from Viti Levu, and it is represented on Pl. XXXII, fig. 15. Mr. Simmonds specially remarked in his letter of June 7, 1919, that it was the only one he had taken. The specimen is referred to in Proc. Ent. Soc. (1919, p. lxxi). The next example, also a male with the character far less developed, is shown on Pl. XXXIV, fig. 6. It was taken with thirteen typical *eschscholtzi* in Vanua Levu, May 25–31, 1921. The third specimen, with the broadest band of the three, is a female taken in Ovalau, April 27, 1922 (see p. 615). It is represented on Pl. XXXVII, fig. 1.

Euploea boisduvalii proserpina.—I may briefly add a few more to the published records of this species in Viti Levu

* Lami, referred to on this page of the Proceedings, is five miles from Suva, on the Waidoi road. On the line above that in which Lami is mentioned, the second ♀ *eleutho* [*eschscholtzi*] should have appeared in the year 1919 instead of 1920. The day and month are correct.

and to those of Mr. Simmonds, appearing for the first time in this memoir. All the following are of the western type of pattern :—4 ♂, 1 ♀ from Suva, in the British Museum; 2 ♂, 1 ♀ from Suva, in the Hill Museum; 4 ♂, 2 ♀ in the Bourke Collection (Suva or Levuka: Jan. 1893).

Euploea tulliolus forsteri.—Of the other members of the association in Viti Levu only three examples of *forsteri* (Pl. XXXIII, figs. 12–14) were received from Mr. Simmonds and none of *nemertes macleayi.* The *forsteri* are of the western type, perhaps not quite so far advanced as those of Vanua Levu (Pl. XXXV), but a good series is required to make sure that this comparison is trustworthy. It is, however, confirmed by an examination of the British Museum series.

There are in the National Collection three males and three females from Suva. They have fore-wings of the western type, and, in the hind, the inner series—there is no trace of the outer—is represented by two faint spots in one male and one female, two fairly distinct in two males, two distinct in two females, one of which, however, has three spots on one side. There are also six males and eight females labelled "Fiji," and these are all of western type except two females with marginal markings reduced, but not to the extent seen in typical eastern specimens. The hind-wing spots of the inner series are never more than two, and these are wanting in four females and very faint in the other four; wanting in two males, and very faint, faint, fairly distinct, and distinct in the four others, respectively.

The Bourke Collection, at Oxford, contains three males and three females, taken in January 1893, either near Suva or near Levuka. As regards the fore-wing pattern, two females are about equal to figs. 18 and 19 on Pl. XXXV and one equal to fig. 20, but with the white spots smaller. Two males are as strongly patterned as figs. 1–3, except that the fused spots are not quite so large. The third male is about equal to fig. 12. There is no trace in the males, and only the faintest in the females of a hind-wing pattern.

There are also in the Hope Department two males labelled "Suva" (C. M. Woodford, Febr., Mar., 1886), two males taken at Suva by Prof. Gilson, Oct. 5 and 8, 1897, four males and two females labelled "Fiji." All are of a distinct, although some of them not very strong, western

type. There is also present a pair of Woodford specimens with the above data which are almost certainly the Australian *tulliolus tulliolus*, labelled in error. When the male was taken to the British Museum Mr. F. A. Heron pointed out that their series of *tulliolus* also contained specimens of the same kind with the same misplaced label.

The Hill Museum possesses three males and two females labelled "Fiji," all with moderately developed western patterns, strongest in the females.

Considering this additional evidence supplied by many examples of *forsteri* from Viti Levu and by others labelled "Fiji," there can be no doubt about the prevalence of the western pattern in the main island, and also great probability that this pattern is not quite so fully developed as in Vanua Levu.

Euploea nemertes macleayi.—The British Museum series includes three males and three females from Suva, resembling Pl. XXXVII, fig. 6 (♂♂), fig. 8 (♀♀), and ten males and twelve females labelled "Fiji." Nearly all are distinct western types, a single female, unfortunately from "Fiji," being as white as the whitest Ovalau female (Pl. XXXVII, fig. 13). It is, however, a large specimen. Two small females with pale brown borders suggest the *graeffiana* strain. Two females nearly resemble Pl. XXXIX, fig. 11, from Mango, and one male is correspondingly dark-bordered. In one male and female internervular white streaks pass outwards from the submarginal white spots as in Pl. XXX, fig. 8, and indications of the same feature appear in other specimens.

The Hope Collection contains two males and one female taken by C. M. Woodford at Suva in February and March 1886. The males are distinctly less white-patterned, especially upon the hind-wing, than the Ovalau male represented on Pl. XXXVII, fig. 7, while the female resembles fig. 8.

The Hill Museum possesses one male from Suva, resembling Pl. XXXIX, fig. 6 (Kandavu), also one male and two females labelled "Fiji," resembling Pl. XXXVII, figs. 6 and 11, respectively (Ovalau).

Dr. Jordan has very kindly compared the Tring series with a good photograph of the specimens from Ovalau shown on Pl. XXXVII. One male from Suva is less advanced than fig. 6, having smaller spots on the fore-wing and fewer on the hind. Six are labelled "Fiji," but

probably came from Viti Levu. Three males, one of them from the Felder Collection, are all like the one from Suva, a little behind fig. 6 in both fore- and, except the Felder specimen, hind-wings. Of the females two, including a Felder specimen, resemble fig. 9, but in one (not Felder) the posterior spots of the hind-wing are rather smaller. The third female resembles fig. 8, but the posterior spots of the fore-wing are smaller and the fore-wing suffused with white on the proximal side of the upper submarginal spots—a feature I have not hitherto encountered except when combined with a white border.

The pattern of this species is therefore of the western type in the main island, but when the record is examined as a whole it will be seen that the average development of the white pattern is distinctly behind that of *macleayi* in Ovalau.

(*c*) Ovalau.

(Plates XXX, figs. 1, 3, 4, 7, 8; XXXVII, XXXVIII, XXXIX, figs. 1–3; XLIII, figs. 3–6, 8.)

On this comparatively small island lying to the east of Viti Levu, the development of a white marginal pattern seems to reach its maximum. This is especially pronounced in the females of *E. nemertes macleayi* such as those shown on Pl. XXXVII, figs. 12, 13. Mr. Simmonds specially mentions these in a letter of July 19, 1922, in which he points out that some of the females are very close mimics of *proserpina*, a conclusion emphasised by a study of Pl. XXXVII. On November 29, 1921, he wrote that *E. tulliolus forsteri* was common on Ovalau, where he had not met with it before. From this it is to be inferred that the four included in the table on p. 617 do not convey a correct impression of its proportions. All four are males with patterns of western type.

Among the forms of *Euploea helcita* was a single specimen (Pl. XXXVII, fig. 1) with the hind-wing pattern of *walkeri* (see also p. 612). It is, however, a rather unusually small example even for *eschscholtzi*, whereas *walkeri*, in the eastern islands of Fiji, is considerably larger than the western race.

Another *helcita* (Pl. XXXIX, fig. 3) is very interesting in the reduction in size and clouding over of the principal spot of the fore-wing, in this respect closely resembling

one of the forms from Wallis I. (Pl. XLII, fig. 12). So far as my experience goes this is the only example of the kind from West Fiji.

The fact that all the four white-patterned Euploeas fly together and that the mimicking Danaine *neptunia* flies with them is well shown in the accompanying table, upon which are recorded all the specimens of these five species from Ovalau received from Mr. Simmonds. Plate XXXVIII emphasises this evidence, inasmuch as the principal model *eschscholtzi* (fig. 1) with its chief mimic *proserpina* (fig. 2) and a female form of *Hypolimnas bolina* (fig. 3) which would resemble them on the wing, were taken within two minutes of each other on a hill near Levuka.

It should be remembered that the Ovalau specimens represented on the plates were not specially selected to show the white pattern, but are fair samples of the others included in the table. Two female *macleayi* (Pl. XXXVII, figs. 12, 13) are, however, exceptional, and were included to show the extent of variation in the species, and also the resemblance to a common form of female *E. graeffiana* (New Hebrides). Allowing for these two, selected for a special purpose, the figures of *macleayi* represent, I believe, an average development of pattern slightly below that of the complete series. I wish the whole could have been figured, as in Pl. XXXV for *forsteri* from one locality in Vanua Levu. I have already implied that all the Ovalau examples of this latter in the table are shown on Pl. XXXVII, figs. 14–17.

In addition to Mr. Simmonds' captures the following specimens from Ovalau are all of western type—*proserpina*: 1 ♂ labelled "Ovalau," in the British Museum; 5 ♂♂ labelled "Levuka: 1882," in the Hill Museum. A little series in the Hope Department, labelled "Levuka: 1878," in the handwriting of Prof. Westwood, includes 1 ♂ *proserpina*, 1 ♂ 1 ♀ *eschscholtzi*, 1 ♀ *Danaida neptunia* (p. 633). The date of the last figure on the *neptunia* is not very clear, but there is no doubt that "8" was intended, as the specimens were evidently labelled together. The Euploeas are of western type and the Danaine is one of the best mimics of this association that I have seen (pp. 631, 637).

The series collected by Admiral Bourke at Suva or Levuka, and described under Viti Levu and on p. 633, should also be taken into consideration.

OVALAU I. Captures in 1920–1922.	*Euploea helcita eschscholtzi.*		*Euploea boisduvalii proserpina.*		*Euploea nemertes macleayi.*		*Euploea tulliolus forsteri.*		*Danaida melissa neptunia.*	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
1920, Sept. 9		1 (XXXVIII, 1)	1 (XXXVIII, 2)							
1921, May 12	5 (XXXIX, 1–3)		2	2	1				1 (XLIII, 4)	
" " 17	5		1	2						
" " 18	2									
" Oct. 22	1						2 (XXXVII, 14, 15)			
" " 23									2	
" " 27	1									
1922, Apr. 27		1* (XXXVII, 1)		1 (XXXVII, 5)	1 (XXXVII, 6)	1 (XXXVII, 9)			2 (XLIII, 3, 5)	
" " 28					1 (XXXVII, 7)	1 (XXXVII, 10)				
" " 29						2 (XXXVII, 11, 13)				
" " 30			2 (XXXVII, 2, 3)	1 (XXXVII, 4)		2 (XXXVII, 8, 12)			1	
" May 3	2		6	1	2	2	1 (XXXVII, 16)		3 (XLIII, 6)	
" " 7					3	1				
" " 8	2		1		1	1				
" " 9			1				1 (XXXVII, 17)			
" " 10						1				
" " 17	1	1	2	1						
" " 18	1		1		1				1 (XLIII, 8)	
" June 7				2						
" " 8		1	1		1	1				
TOTALS	20	4	18	10	11	12	4	0	10	0

* The hind-wing has the pattern of *helcita walkeri*.

(*d*) Moturiki.

(Plate XXXVI, figs. 1 and 2.)

There is little to be said about this small island, which lies close to Ovalau, on the south-west side of it. Moturiki was visited by Mr. Simmonds on August 11, 1920 and in 1923, when it was found to be very barren (p. 576). The two Euploeas captured in 1920 were females of *eschscholtzi* (fig. 1) and *proserpina* (fig. 2), both of the western type like those of the adjacent islands Ovalau and Viti Levu. The pattern of *proserpina* is developed to an extent which is somewhat unusual. The specimens are recorded in our Proceedings, 1920, p. lxxxi.

(*e*) Vanua Levu.

(Plates XXX, figs. 2, 5, 6; XXXIV; XXXV.)

Until I received the excellent series of Euploeas sent by Mr. Simmonds I had only found (in the British Museum Collection) three specimens with labels showing that they came from this fine island, next to Viti Levu much the largest in the group. Mr. Simmonds visited it on several occasions, by far the most prolific visit being to Vunilagi, on the north-east coast on May 25–31, 1921. This locality is not given on any maps of the island, and the Geographical Society have not been able to find a reference to it, but they kindly inform me that "Vunilangi" is a village on the south coast of Vanua Levu. It is too late to obtain verification from Mr. Simmonds before the appearance of this memoir, but should any correction be found necessary it will be made at the earliest opportunity.

All the Euploeas captured at Vunilagi are represented on Plates XXXIV and XXXV, and they are sufficiently numerous to create an accurate picture of the average patterns, which are seen to be of a pronounced western type. The locality was near sea-level, and included patches of primitive jungle.

In addition to the Vunilagi Euploeas the following captures were made at other times in various parts of the island.

All the Euploeas here tabulated are of pronounced western type, the patterns of *forsteri* being unusually strong, with distinct hind-wing spots, like those shown on Pl. XXXV.

VANUA LEVU. LOCALITIES AND DATES.	*E. helcita eschscholtzi.*		*E. boisduvalii proserpina.*		*E. tulliolus forsteri.*	
	♂	♀	♂	♀	♂	♀
E. Coast: Buca Bay. Dec. 27, 1921.				2	1	
S. Coast: Wainunu. Feb. 19, 1922.		1			1	
S. Coast: Wainunu. Mar. 1, 1922.	1					
N. Coast: Macuata distr. Sept. 18, 1922.	1	2				2

Euploea helcita eschscholtzi.—Although this species is often less abundant than its chief mimic *proserpina*, it was much commoner at Vunilagi—three times as numerous according to Mr. Simmonds' letter quoted below. The male represented on Pl. XXXIV, fig. 6, has been already referred to on p. 612, as tending towards the *walkeri* form in the hind-wing pattern.

Euploea boisduvalii proserpina.—The patterns of the females (Pl. XXXIV, figs. 19–22) are as usual stronger than those of the males (figs. 15–18), and the dyslegnic edges of the markings are very evident. The fore-wing brand of the male represented in fig. 15 is exceptionally small, a good example of the variability of this character.

In addition to Mr. Simmonds' material a male and female from Vanua Levu exist in the British Museum Collection—both of western type.

Euploea tulliolus forsteri.—Concerning this species Mr. Simmonds wrote on June 12, 1921, a few days after taking the butterflies represented on Plates XXXIV and XXXV :—

"At Vunilagi the purple *Euploea* was by far the most abundant of the group, being in the proportions of not less than 5 to 3 of the *eschscholtzi* and to 1 of *proserpina.*"

These proportions are all the more interesting because of the comparative scarcity of *forsteri* in Viti Levu. There is probably great variation from time to time in the proportions of all the members of the group. Thus Mr. Simmonds has noted the sudden appearance in numbers of this species on Ovalau (p. 615). Such changes probably play an important part in the rapid evolution of reciprocal mimicry.

The much higher average development of pattern in

the females is well shown when figs. 16–21 are compared with 1–15 on Pl. XXXV; also the much greater variability of this sex, for fig. 21 is less patterned than the darkest male (fig. 15), although the female series is, as a whole, far more strongly patterned.

The development of a hind-wing pattern with two rows of spots seems to be carried further in Vanua Levu than elsewhere in Fiji, but longer series from other islands are required in order to confirm this impression. It will be seen from Pl. XXXV that this feature is more strongly developed in the females, although figs. 4, 6 and 8 represent males in which both rows of spots are distinct. All the specimens sent by Mr. Simmonds are *forsteri* except three male and one female *protoforsteri* (Pl. XXXV, figs. 13–15, 21).

Euploea nemertes macleayi.—I only know of a single specimen of this species from Vanua Levu, a female of western type (like Pl. XXXVII, fig. 8) from the south-east coast, in the British Museum.

(*f*) Taveuni.

(Plates XXXVI, figs. 3–12; XLIII, figs. 1, 2. *All figures quoted without further reference are from Plate XXXVI.*)

Three of the Fijian Euploeas were collected by Mr. Simmonds, December 11–21, 1921, two of them on March 18, 1922, and a single *proserpina* on March 9 of the same year. The date at which each was captured is recorded in the explanation of the plate. All the Euploeas received are figured except three male *proserpina* (December 19, 1921, March 9 and 18, 1922), with patterns intermediate between those of the males represented in figs. 5 and 6.

Euploea helcita eschscholtzi.—The male (fig. 3) and female (fig. 4) are typical examples of this race.

Euploea boisduvalii.—All are of the race *proserpina* except the male represented in fig. 7, which is beautifully transitional towards *simmondsi*, and more primitive than any in the long Fijian series of the species except the single specimen from Kandavu (Pl. XXXIX, fig. 5), one from Thithia (Pl. XL, fig. 1) and three from Vanua Balavu (Pl. XLI, figs. 1–3). The specimen is also remarkable for its great size and the length and relative narrowness of the male brand on the fore-wing (pp. 594, 595). In this latter respect it confirms the conclusion arrived at from other

specimens, that this secondary sexual character is excessively variable and that to place any reliance upon it for classificatory purposes is extremely unsafe. The appearance of the specimen was so peculiar that I asked Dr. Eltringham if he would kindly examine the armature, but the investigation entirely supported the conclusion that the specimen was *boisduvalii*. It was taken on March 18, 1922, together with one of the unfigured males of *boisduvalii proserpina* and the male of *tulliolus forsteri* shown in fig. 10. Apart from this most interesting specimen, the five male *proserpina* are rather more primitive than those, represented on Pl. XXXIV, figs. 15–18, from the adjacent large island of Vanua Levu, while the more advanced development of the white marginal pattern in the female *proserpina* is strikingly shown when the two Taveuni females (figs. 8 and 9) are compared with the two males shown in figs. 5 and 6 and with the three unfigured examples.

The Hill Museum possesses a male specimen labelled "Niusawa, Taveuni. April. 1905." It resembles fig. 6.

Euploea tulliolus forsteri.—The two males (figs. 10 and 11) and one female (fig. 12) exhibit, like the male *proserpina*, a less developed pattern than that seen in the form from Vanua Levu. When figures 10–12 are compared with 1–21 on Pl. XXXV it will be recognised that the average pattern is distinctly stronger in the latter.

Euploea nemertes macleayi.—Although the Hope Department possesses no example of this species from Taveuni, there are two males and one female from this island in the British Museum. One male is nearly as strongly white-bordered on the fore-wing as the Ovalau female represented on Pl. XXXVII, fig. 13, but the hind-wing spots are very small and few, and the border is dark. The second male is very dark, especially so in the hind-wings, and probably on the whole equals the Balavu male (Pl. XLI, fig. 11). The female resembles Pl. XXXVII, fig. 8.

It is interesting to find that the Euploeas of this, the easternmost island of the western group, are somewhat more primitive than those of any other except the next island Kandavu, which, although not so eastern in position as Taveuni, is far more remote.

(*g*) Kandavu.

(Plate XXXIX. *All figures quoted without further reference are from this plate—figs.* 4–9.)

The little assemblage, taken in this outlying southern island on July 24, 1921, includes one example or more of all the four Fijian Euploeas. All are represented on the plate.

Euploea helcita eschscholtzi.—A typical male (fig. 4).

Euploea boisduvalii.—The single male (fig. 5) is one of the most interesting specimens (p. 628) captured by Mr. Simmonds, being a beautiful intermediate between *simmondsi* and *proserpina*, and nearer to the former than any specimen known from any Fijian island except the eastern Thithia and Vanua Balavu.

Mr. Simmonds referred to this specimen in a passage which, in view of the longed-for series, is somewhat tantalising :—

" *July* 31, 1921.—There is also a *Euploea* from Kandavu, and I think you will find that this differs from the Ovalau form in the smaller area of white spots. I think this was the commonest species at Kandavu, although *tulliolus forsteri* was common."

Euploea tulliolus forsteri.—The single male is western in pattern, having distinct traces of a double series of spots on the hind-wing and a strongly developed pattern on the fore-wing, differing widely in both these respects from the Mango specimens represented in figs. 12–18 on the same plate.

Euploea nemertes macleayi.—The single male (fig. 6) and one of the two females (fig. 7) are rather dark forms for this race, the latter nearly as dark as the Mango female (Pl. XXXIX, fig. 11), the former in some features darker, in others lighter than the darkest Ovalau male (Pl. XXXVII, fig. 6). The second female (fig. 8) bears a more developed pattern, and outside the series of spots the ground-colour becomes pale as in the Ovalau female shown in Pl. XXXVII, fig. 12. The spots, however, are about as in the female from the same island represented in fig. 8 of the same plate.

There is a female from this island in the British Museum series. It is of western type, resembling Pl. XXXVII, fig. 8.

A long series of all the Euploeas from Kandavu is much to be desired. The evidence, so far as it goes, suggests that *eschscholtzi* reached this rather remote island later than those of the western group, and has therefore produced less effect. The assemblage, as a whole, may be compared with that shown on Pl. XL, from the eastern island Thithia (Cicia), where, however, *helcita walkeri* takes the place of *eschscholtzi*.

II. The Islands of East Fiji, including Moala.

(*a*) Moala.

(Long. 179° 50′ E.; Lat. 18° 35′ S.)

This small isolated island is due south of the south end of Taveuni and south of a point midway between Kandavu and the group of three eastern islands to be considered next —Thithia, Mango, and Vanua Balavu.

I have only seen a single butterfly from the island, a male *Euploea tulliolus forsteri* in the British Museum. It is, as we should expect, eastern in pattern, resembling the males from Mango with which it is placed in the Museum series, but the blue spots of the fore-wing show rather more evident traces of white. Its resemblance to a race in the Loyalty Is. has already been mentioned (p. 600).

A good collection from isolated islands such as Moala may be expected to throw much light on the patterns of the original invaders.

(*b*) Thithia (Cicia).

(Plates XXXI, figs. 4, 8; XL. *All figures quoted without further reference are from Plate XL.*)

Mr. Simmonds visited this eastern Fijian island on August 31 and again on December 8, 1921, and collected in Vanua Balavu a day later on both occasions. Two or more examples of each of the four Fijian Euploeas were taken on August 31—(figs. 1–13). The character of the collecting ground is described on p. 627.

The whole of the Euploeas received from Thithia are figured. The assemblage, although darker than in any western Fijian island, is less dark than that of Mango, as will be recognised when figs. 3–8, and 14 are compared with 11–18 on Pl. XXXIX. Comparison with Pl. XLI

will show that the Euploeas of Vanua Balavu were on the whole darker than either of the other eastern islands.

In this and the remaining islands the order of the associated Euploeas is changed in accordance with the plates, the form of *E. helcita*—now the race *walkeri* (although often modified) instead of *eschscholtzi*—being placed last instead of first. This change has been made to indicate that in these eastern islands *helcita* acts as a mimic rather than a model, although there is reciprocal approach on the part of the dark Euploeas which, in most of the examples, is so strong in Thithia that the earlier arrangement would perhaps have been better. But we cannot be sure of this until more specimens have been collected in the island.

Euploea boisduvalii.—Of the two examples fig 1 represents the darkest *simmondsi* hitherto taken in Fiji, except that shown in Pl. XLI, fig. 3. A slight trace of a submarginal pattern is seen at the apex of the fore-wing. Fig. 2, on the other hand, is intermediate between *simmondsi* and *proserpina*, resembling a small proportion of the examples found on western islands, *e. g.*, those from Viti Levu represented on Pl. XXXIII, figs. 5, 6 and 11. Like these last, the specimen from Thithia is well advanced towards *proserpina*, considerably more so than the single example of *boisduvalii* taken on Kandavu (Pl. XXXIX, fig. 5), and rather more than one of those from Taveuni (Pl. XXXVI, fig. 7).

Euploea tulliolus forsteri.—The three males (figs. 5, 6 and 14) and one of the females (fig. 7) are *protoforsteri*, but very near the border-line between this form and *forsteri*, while the second female (fig. 8) is a pronounced example of the latter with two rows of spots on the hind-wing. Faint traces of the same feature are to be seen in the males, especially the one represented in fig. 14. The advance towards the western pattern, although much behind that of West Fiji, is thus ahead of that reached in Mango or Vanua Balavu—a result consistent with the pattern of the intermediate *boisduvalii* (fig. 2).

Euploea nemertes macleayi.—The two females (figs. 3, 4) exhibit a stronger pattern than that of the single female from Mango (Pl. XXXIX, fig. 11), but far weaker than in those from Ovalau (Pl. XXXVII, figs. 8–13). Of the two females from Kandavu, represented on Pl. XXXIX, one (fig. 7) has a somewhat weaker and the other (fig. 8) a distinctly stronger pattern than the examples from Thithia.

All three species of dark *Euploea* seem therefore to show a marked diaposematic approach towards *helcita walkeri*, which itself exhibits traces of reciprocal influence, as will be indicated below.

Euploea helcita walkeri.—The five males (figs. 9–12, and 15) and one female (fig. 13) are all typical examples of this form except one (fig. 11), which approaches *eschscholtzi*. Furthermore, the partial clouding over of the principal fore-wing spot in figs. 9 and 10, its slightly dyslegnic lower border in the others, and the more or less distinct trace of a notch in its outer end, to be seen in all but fig. 9, are modifications, shown by comparison with other island forms, *e. g.*, those figured on Pl. XLII, to be a small variation which may lead towards reduction.

So far as the evidence goes *walkeri* appears to be the commonest of the four species of *Euploea* in Thithia.

(*c*) **Mango.**

(Plates XXXI, figs. 5, 6; XXXIX, figs. 10–18. *All figures quoted without further reference are from* Pl. XXXIX.)

This island is more eastern in position than Thithia, but less so than Vanua Balavu. Mr. Simmonds visited it December 8, 1921, and all the Euploeas received from him are represented in figs. 10, 12–18.

Euploea boisduvalii.—It is very unfortunate that no Mango example of this species exists, so far as I am aware, in any collection. There can be little doubt that it is among the island butterflies; for Mr. G. F. Mathew informs me that he saw four species of *Euploea* there on June 12, 1884. Looking at the reduced patterns of *macleayi* and *protoforsteri* (figs. 11 and 12–18), it is highly probable that the Mango race of *boisduvalii* is *simmondsi*. It is to be hoped that this prediction may be tested at an early date.

Euploea tulliolus protoforsteri.—The five males and two females (figs. 12–16 and 17, 18) are darker than any examples of this *Euploea* sent by Mr. Simmonds from other Fijian islands; and, as the British Museum series of four males and two females is very similar, we may feel confident that this dark butterfly with a greatly reduced pattern in which the partially white spots become entirely

blue, is the prevalent form in Mango. It will be seen that the darkest Oxford specimen (fig. 12), a male, is patternless. In the British Museum series, on the other hand, the darkest, patternless specimen is a female. The hind-wing pattern is wanting, except for two vestigial spots on one male in the British Museum. The faint trace seen on the right side of fig. 18 is due to the under surface spots showing through. This under surface pattern is also extremely reduced in the series of both museums.

There are also in the Hill Museum two examples labelled "Mago" from the Grose-Smith Collection—a male resembling fig. 15, and a female resembling fig. 18.

Euploea nemertes macleayi.—The female represented in fig. 11 was kindly lent me by the British Museum authorities. It was captured by C. M. Woodford on July 18, 1882. Its pattern is much reduced, especially on the hind-wing. There are also two females labelled "Mago" from the Grose-Smith Collection in the Hill Museum. The development of pattern is about equal to that of the Kandavu female represented in fig. 7, and therefore slightly greater than the British Museum example.

Dr. Jordan has kindly compared the Tring examples from Mango with a photograph of the Ovalau specimens shown on Pl. XXXVII. Two males have fewer and smaller spots than those represented in figs. 6 and 7 of that plate; the single female has smaller spots on the fore-wing and fewer on the hind than fig. 8.

Euploea helcita walkeri.—The single example received from Mr. Simmonds is the typical female represented in Pl. XXXIX, fig. 10.

Capt. Riley has kindly sent me a note on the Mango *helcita* in the British Museum. A male has the principal spot of the fore-wing much suffused, like *intermedia*, and the hind-wing pattern intermediate between that of *walkeri* and *eschscholtzi*, but much nearer the latter. Of three females two are typical *walkeri* and the third, in the hind-wing at any rate, typical *eschscholtzi*.

Two males in the Tring Museum are labelled "Mango," with the name "*intermedia*." Both resemble the darkest example from Vanua Balavu (Pl. XXXI, fig. 1), one having the chief spot rather more clouded over than the figure, the other rather less so. The subapical fore-wing spots are much reduced, especially in the former. The specimens are large, like *walkeri* in this part of its range, but

the hind-wing pattern is, as in this Vanua Balavu example, that of *eschscholtzi*.

Of two males in the Hill Museum, one labelled "Mango, 1882," also resembles Pl. XXXI, fig. 1, except that the hind-wing is intermediate between *eschscholtzi* and *walkeri*. The second labelled "Mago," from the Grose-Smith Collection, resembles Pl. XLI, fig. 13, except that in the fore-wing the principal spot is slightly less, and the sub-apical series slightly more, reduced. The hind-wing pattern is as in the last specimen.

More evidence is required, but on the facts before us, the three Euploeas of Mango appear to be darker than those of any other island except Vanua Balavu. Indeed, *protoforsteri* is darker than in this latter island. The two other species are not quite so dark, but there is only one *macleayi* from Vanua Balavu, so that the comparison is not very trustworthy.

(*d*) Vanua Balavu (Bavatu).

(Plates XXXI, figs. 1–3, 7; XLI. *All figures quoted without further reference are from* Plate XLI.)

Vanua Balavu, the most eastern Fijian island in which Mr. Simmonds collected, was visited on September 1, and again on December 9, 1921. On this latter date one or more representatives of all four species of *Euploea* were taken, viz. the specimens shown in figs. 3, and 8–15.

The collecting-ground, similar to that of Thithia, was "near sea-level in patches of primitive jungle, perhaps growing on rough limestone land too rocky to cultivate. Naturally these places were the most prolific."

Mr. Simmonds recognised that the dark form of *Euploea boisduvalii* (figs. 1–3) was the local race (*simmondsi*), representing *proserpina* of western Fiji, and that *E. tulliolus protoforsteri* had, in some specimens (*e.g.*, figs. 5 and 8), the "white spots on the upperside almost suppressed."

The whole of the Euploeas received from V. Balavu are represented on Plate XLI. The assemblage of the three dark Euploeas (figs. 1–11) is, on the whole, the darkest of any received from a Fijian island.

Euploea boisduvalii simmondsi.—The three male specimens (figs. 1–3) are all *simmondsi*, figs. 1 and 2 showing a

slight development of the marginal pattern. The position of the minute spot between veins 3 and 4 of the fore-wing foreshadows its inward development in *proserpina*, as will be recognised if the following succession of figures be compared—Pl. XLI, fig. 1; Pl. XXXIX, fig. 5; Pl. XXXVI, figs. 7, 6, 5.

The specimen of *simmondsi* represented in fig. 1 is especially interesting in the pale brown border, clearly recalling an ancestral form in the New Hebrides—*paykullei*, although marginal white spots are never found on the upper surface in this race (pp. 592, 594). The same pale border is feebly indicated in fig. 2 and strongly in fig. 3, but the specimen being worn and faded the resemblance to *paykullei* is less evident.

Euploea tulliolus protoforsteri.—The six males (figs. 4–9) and one female (fig. 10) are the darkest set received from any Fijian island except Mango (Pl. XXXIX, figs. 12–18), two of the males (figs. 5 and 8) being almost patternless and none of the others with strongly developed marginal spots. Reciprocal mimicry is most evident in the female (fig. 10), in which alone a faint trace of a pattern appears on the hind-wing. This last specimen is intermediate between *protoforsteri* and *forsteri*.

Euploea nemertes macleayi.—The single male (fig. 11) is the darkest of any example of the species taken by Mr. Simmonds. It is unfortunately the only specimen from this East Fijian Island.

Euploea helcita walkeri.—The three males (figs. 12–14) and one female (fig. 15) are extremely interesting. They are all probably *walkeri* forms modified by mimetic approach towards the dark Euploeas. Figs. 13 and 14 are typical *walkeri* in the hind-wing pattern and also in the fore-wing except for the partial clouding over of the main spot. Fig. 12 has the hind-wing pattern of *eschscholtzi*, and fig. 15 has nearly reached the same condition, but in size the specimens all resemble *walkeri* from eastern Fiji. The reduction of the principal spot is carried furthest in fig. 12, and both it and fig. 15 show on the outer end of the spot a minute notch which is emphasised in races where the reduction is carried much further, *e.g.*, in the Wallis I. forms (Pl. XLII, figs. 8–12).

III. Wallis and Fotuna* Islands, about midway between Fiji and Samoa.

(Plates XLII, figs. 1–12, Wallis I.: XLII, figs. 13–19; XLIV, fig. 4, Fotuna I.)

These two small islands lie about midway between Samoa and Fiji, Fotuna being 178 stat. miles N.E. of Cape Undu, at the N.E. tip of Vanua Levu, and 296 miles from Nairai, the centre of the Fiji group; Wallis being 322 and 430 miles from the same points, and the two islands 150 miles apart. All the Euploeas received from these islands are represented on the plate.

Mr. Simmonds visited Fotuna May 25 and 26, 1922, and found only one species of *Euploea*, viz. *helcita walkeri* (figs. 13–19). The form is similar to that from the Societies, where it is the only *Euploea*.

Wallis I. was visited, May 30, 1922, and here two Euploeas were found—the *simmondsi* race of *E. boisduvalii* (figs. 1–7) and, accompanying this dark subspecies, a form of *helcita* with greatly reduced markings (figs. 8–12). This is similar to a form from the Ellice Islands, named *distincta* Butl., in the British Museum.

One male (fig. 2) and two females (figs. 6, 7) of *simmondsi* exhibit a reciprocal mimetic approach to the forms of *helcita*, thus resembling some of the examples of *simmondsi* from Thithia and Vanua Balavu. This will become clear when figs. 2, 6, 7 are compared with figs. 1, 2 on Pls. XL and XLI, especially the latter. Unfortunately no female *simmondsi* were received from these two Fijian islands, but on Wallis I. the female represented in fig. 7 exhibits the strongest diaposematic approach to the forms of *helcita*. This is only to be expected in a race conspecific with *proserpina*, but it is to be hoped that far more evidence will become available in the near future.

Mr. Simmonds wrote on June 19, 1922, of his visit to the two islands, pointing out that the *E. helcita* from Wallis and Fotuna were distinctly different, and referring to "a *Euploea* near *proserpina* from Wallis, possibly new." Of the general butterfly fauna he wrote—"Butterflies were not numerous on Wallis or Fotuna, and I did not see *Papilio* or *Atella*, both of which occur in Samoa, and I expected to find them.

* Futuna is the spelling accepted by the P.C.G.N. of the Royal Geographical Society.

"I saw on Wallis—*bolina*, *helcita*, *J. woodfordi*, *D. archippus*, the strange *Euploea*, a skipper and two Lycaenids. Fotuna was the same except for the second *Euploea* and *D. archippus*.

". . . . It was interesting to find so marked a difference between the Euploeas of Wallis and Fotuna."

It would be difficult to find a more convincing illustration of mimetic approach than that afforded by a comparison of the Euploeas on these two islands.

G. THE EVOLUTION OF DANAIDA MELISSA NEPTUNIA FROM PROTONEPTUNIA IN FIJI. PROPORTIONS OF THESE FORMS IN DIFFERENT ISLANDS.

(Pls. XXXII, fig. 10; XXXIII, figs. 15–18; XLIII, all; XLIV, figs. 6, 7. *Figures quoted without further reference are from* Pl. XLIII.)

In the following pages I have adopted the opinion set forth in the British Museum Collection, that the pale Fijian Danaine *claribella* Butl. is a relatively rare female form of *neptunia*. In a previous section (p. 608) the non-mimetic or least mimetic forms of *neptunia*, similar to figs. 1–3, have been given the name *protoneptunia*, *neptunia* being retained for specimens resembling figs. 7–9, which also resemble Felder's figure, figs. 4–6 being regarded as transitional.

The mimetic relationship between this Danaine and the Euploeines is of the greatest interest. It will be seen that in Fiji a high proportion of the specimens of the Danaine have almost or sometimes entirely lost the pale markings on the basal half of the fore-wing and, to a less extent, on the same part of the hind; so that, upon the wing, they superficially resemble the white-bordered, dark Euploeas of West Fiji. What has happened in East Fiji we do not sufficiently know, because only a few examples of the Danaine have been received from these islands. The seven specimens from Taveuni (the western island nearest to East Fiji) and Mango (p. 639) suggest, however, that the reduction of pattern has not been carried so far in the islands where *helcita walkeri* is apparently the only *Euploea* normally possessing a pronounced marginal pattern. Large numbers of specimens from as many islands as possible are very much wanted in order to test this suggestion.

I had always felt confident that *neptunia* was a mimic of the Euploeas ever since I first noticed what was, until 1919, the only example in the University Collection, a dark female taken at Levuka (p. 616). The suspicion was entirely confirmed in 1919, when I received specimens from Mr. Simmonds, and above all his observation that the Danaine "flies with the Euploeas and is very difficult to distinguish when on the wing. They occur as 1 to 20 or 30 of the two Euploeas"—*helcita eschscholtzi* and *proserpina* (Proc. Ent. Soc., 1919, p. lxx). Furthermore, as material accumulated, it became evident that a larger proportion of the females were advanced in the direction of mimetic resemblance than of the males (Proc. Ent. Soc., 1920, pp. lxxx, lxxxi).

Referring to these communications, Mr. G. Talbot, in "Bull. Hill Mus." (vol. i, No. 1, p. 24, 1921), published an excellent figure (Pl. IV, A, fig. 3) of a male about midway between the most developed (*protoneptunia*) and the most reduced patterns (*neptunia*), very similar to that shown on Pl. XLIII, fig. 5.

In order to determine as far as possible the relation of sex and locality to the mimetic reduction of pattern it was important to compare all the specimens that were available—an investigation in which much kind help has been received from scientific colleagues. The results appear in Tables A–D (pp. 632–636).

The figures on Plate XLIII represent specimens chosen to illustrate the progressive reduction of the internal parts of the pale pattern, from fig. 1, showing about the maximum development found in *protoneptunia*, to fig. 9, showing the minimum in *neptunia*. Figs. 1–3 represent, by means of three specimens of *protoneptunia* arranged in the order of gradually increasing reduction of the internal pattern, the group described in Section I of the following Table A, which includes all the specimens of this Danaine received from Mr. Simmonds, over and above the nine shown on the plate, the data of these latter being fully recorded in the explanation. Figs. 4–6 and 7–9 similarly represent, respectively, the groups described in Sections II (transitional) and III (*neptunia*) of Table A. It will be observed that this table also includes Section IA, not represented on Pl. XLIII. This section was created in order to contain additional transitional specimens which have nearly lost the three basal marks of the fore-wing,

TABLE A.

Specimens of *D. melissa neptunia* in the Hope Dept., collected by H. W. Simmonds, in addition to the nine represented on Pl. XLIII.

I. *Protoneptunia*. Ancestral pattern well developed. Similar to figs. 1–3, and like these arranged in order of increasing reduction in F.W. pattern.			
1	S. Viti Levu, Waidoi . .	May 27, 1919.	♀
2	Ovalau	Oct. 23, 1921.	♂
3	Taveuni, Ura	Mar. 18, 1922.	♂
4	S. Viti Levu, Waidoi . .	June 1, 1919.	♂
5	Taveuni, Ura	Mar. 18, 1922.	♀
6	S.E. Viti Levu, Nasinu .	Apr. 10, 1921. Pl. XXXIII, figs. 15, 16.	♂♂
IA. *Transitional*. Further reduction of innermost part of F.W. pattern, but retention of mark in outer part of cell, although reduced in the ninth and greatly reduced in the tenth specimen.			
7	Ovalau	May 3, 1922.	♂
8	Taveuni	Dec. 11, 1921.	♀
9	S. Viti Levu, Waidoi . .	June 6, 1919. Pl. XLIV, fig. 7.	♂
10	Ovalau	Apr. 30, 1922.	♂
II. *Transitional*. Innermost F.W. pattern as in IA, but the aviform mark in the cell absent. Similar to figs. 4–6, and like these in order of increasing reduction of F.W. pattern.			
11	Naviti, Yasawa Group .	Oct. 13, 1921. Pl. XXXII, fig. 10.	♂
12	S.E. Viti Levu, Nasinu .	Dec. 18–19, 1919.	♀
13	Ovalau	Oct. 23, 1921.	♂
III. *Neptunia*. Inner half of F.W. patternless or with faint traces only, and of H.W. greatly reduced in darkest specimens. Similar to figs. 7–9 and similarly arranged. The last six specimens with F.W. as dark as in figs. 8 or 9, but H.W. of none quite so patternless as in fig. 9.			
14	S. Viti Levu, Waidoi . .	May 27, 1919.	♀
15	S.E. Viti Levu, Nasinu .	Apr. 10, 1921. Pl. XXXIII, fig. 17.	♂
16	S. Viti Levu, Waidoi . .	June 5, 1919.	♂
17	S.E. Viti Levu, Nasinu .	Apr. 10, 1921. Pl. XXXIII, fig. 18.	♂
18	S. Viti Levu, Waidoi . .	June 20, 1919.	♀
19	Ovalau	May 3, 1922.	♂
20	S. Viti Levu, Waidoi . .	June 1, 1919.	♂
21	S.E. Viti Levu, Lami . .	Aug. 28, 1920. Pl. XLIV, fig. 6.	♂
22	” ” ”	Aug. 28, 1920.	♂

but still retain the irregular aviform mark in the outer part of the cell, as in Pl. XLIV, fig. 7.

Great care has been taken to insure that the sections in the different tables correspond with one another, and for this purpose the nine specimens shown on Pl. XLIII and the four in IA of Table A were taken to London in order that the British Museum series of *neptunia* might be compared with them.

In addition to the splendid series collected by Mr. Simmonds, the Hope Department possesses the female *neptunia* from Levuka mentioned on p. 616. It resembles No. 27 of Table B, and, like it, is very nearly as dark as fig. 9. Furthermore, the collection recently presented by Admiral Edmund Bourke contains three male *neptunia*, collected January 1893, either at Suva or Levuka. Two resemble fig. 7, and one fig. 8.

Table B.

Specimens of *D. melissa neptunia* in the Zoological Museum, Tring.

I. *Protoneptunia.* As in Table A and similar to figs. 1–3.			
1	Suva, Nov. 1894: Wet Season. Woodford .	Resembles fig. 1.	♀
2	Fiji	„ „ 2.	♂
3	Fiji	„ „ 2.	♂
4	Suva (1895). Woodford	„ „ 3.	♂
IA. *Transitional.* As in Table A. An example is shown on Pl. XLIV, fig. 7.			
5	Fiji	Resembles No. 8 of Table A.	♂
6	Suva (1895). Woodford	„ No. 8 „ „	♀
7	Suva, Nov. 1894: Wet Season. Woodford .	Slightly darker than No. 10 in Table A. Probable beak-mark on R.F.W.	♂
8	Fiji	Slightly darker than No. 10 in Table A.	♀
II. *Transitional.* As in Table A and similar to figs. 4–6.			
9	Fiji	Resembles fig. 5.	♂
10	Fiji	Between figs. 5 and 6.	♀

III. *Neptunia.* As in Table A and similar to figs. 7–9.			
11	Fiji (85)	Resembles fig. 7.	♂
12	Fiji	,, ,, 7.	♂
13	Fiji	,, ,, 8.	♂
14	Fiji	,, ,, 8.	♂
15	Coll. Felder (5) "*neptunia*"	,, ,, 8.	♂
16	Suva, Nov. 1894: Wet Season. Woodford .	Between figs. 8 and 9. Very faint trace of line within inner margin of F.W. Probable beak-mark on L.F.W.	♀
17	Fiji (85)	Resembles No. 16.	♀
18	Fiji	,, ,, 16.	♂
19	Fiji	Between figs. 8 and 9.	♂
20	Suva, Nov. 1894: Wet Season. Woodford .	,, ,, ,, ,,	♂
21	Fiji	,, ,, ,, ,,	♂
22	Suva, Nov. 1894: Wet Season. Woodford .	,, ,, ,, ,,	♂
23	Suva, XI, XII, 1894. Woodford . . .	,, ,, ,, ,,	♀
24	No data	Nearly as dark as fig. 9, even in H.W.	♀
25	Fiji	Nearly as dark as fig. 9, even in H.W.	♀
26	Fiji	Nearly as dark as fig. 9, even in H.W.	♀
27	Suva, Nov. 1894: Wet Season. Woodford .	Nearly as dark as fig. 9, even in H.W.	♀

TABLE C.

Specimens of *D. melissa neptunia* in the British Museum.

I. *Protoneptunia.* As in Table A.			
1	Fiji (Crowley) . . .	Lighter than fig. 1, especially in H.W.	♀
2	Fiji (Crowley) . . .	Resembles fig. 1.	♂
3	Fiji (Godm. and Salv.).	Resembles fig. 2, but H.W. very dark, compared with figure.	♂
4	Fiji (Godm. and Salv.) .	Resembles fig. 3.	♂
IA. *Transitional.* As in Table A.			
5	Fiji (Crowley) . . .	Resembles No. 7 of Table A.	♂
6	Tairuni, Mango, IX, 1882. Woodford .	,, No. 8. ,, ,,	♀

II. *Transitional.* As in Table A.			
7	Fiji (Godm. and Salv.) .	Resembles fig. 4.	♂
III. *Neptunia.* As in Table A.			
8	Fiji (Godm. and Salv.).	Resembles fig. 8.	♂
9	Natova, Fiji, 25. X. 1918. R. Veitch. . . .	„ „ 8.	♂
10	Fiji (Crowley) . . .	„ „ 8.	♂
11	Fiji (Crowley) . . .	„ „ 8.	♀
12	Fiji (Hewitson) . . .	„ „ 8.	♀
13	Fiji (Hewitson) . . .	„ „ 8.	♂
14	Fiji (Rego : G. and S.).	„ „ 8.	♂♂
15	Suva, II–III, 1886. Woodford . . .	„ „ 8.	♂
16	Fiji (Rego : G. and S.).	„ „ 9, but H.W. not so dark as fig.	♂
17	Fiji (Hewitson)	Resembles No. 16.	♀

In addition to the 18 specimens tabulated above, 2 others in the British Museum Collection are considered separately.

The name *claribella* was given by Butler to a remarkable female with the pale markings immensely developed and confluent over the basal area of both wings. The type bears "Viti" (= Fiji), and was purchased from the Godeffroy Museum in 1882. That the locality is correct is shown by a second female with the data "Natova, Fiji, 27. X. 18. R. Veitch." It was therefore taken within two days of the capture of male No. 9 in the above Table C. *Claribella* is, I believe, correctly labelled in the British Museum series as a female form of *neptunia*. If this be so, its female, like that of *Euploea tulliolus forsteri* (pp. 619, 620), varies in both directions—towards a stronger pattern and towards a weaker one—more freely than the male.*

The second specimen, also a female, is from the Banks Collection. It bears the locality "Fiji," but has been labelled "probably from Tonga." The basal part of the fore-wing resembles fig. 9, but the distal markings are

* On January 14, 1920, Mr. Simmonds wrote: "I took what I believe to be a lovely variety of *neptunia* in which the greenish-white ground-colour is enormously extended, when it makes a beautiful insect." There can be little doubt that this is a third example of *claribella*, and it will be very interesting to know whether it is a male or female.

very strong, and the hind-wing markings even stronger than in fig. 1. The specimen, if from Fiji, supplies further evidence of the superior power of variation in the female of this race.

Table D.

Specimens of *D. melissa neptunia* from the Hill Museum, Witley.

I. *Protoneptunia.* As in Table A.			
1	Tairuni, Fiji, 1882. [Mango. Compare data of No. 6, Table C.]	Resembles fig. 1.	♂
2	Suva. Woodford . .	„ „ 2.	♂
3	Suva	„ „ 3.	♂
IA. *Transitional.* As in Table A.			
4	Fiji	Between Nos. 9 and 10 of Table A.	♂
II. *Transitional.* As in Table A.			
5	Suva	Resembles fig. 5. Bull. Hill Mus., Vol. i, pl. IV, A, fig. 3.	♂
III. *Neptunia.* As in Table A.			
6	Fiji	F.W. resembles fig. 9; H.W. is between figs. 7 and 8.	♂
7	Fiji	Resembles No. 6.	♂
8	Fiji: Rego	„ No. 6, but H.W. resembles fig. 8.	♂

The whole of the specimens in the tables, with the additional specimens in the Hope Department, are tabulated on p. 637, so as to show the distribution of the sexes in the four sections.

Thus, 33 out of 65 males, or $\frac{1}{2}$, are in Section III (*neptunia*), with the most reduced pattern; 14 out of 24, or $\frac{7}{12}$, of the females. At the opposite end of the scale, with the greatest development of pattern, the difference

is more striking, 17 out of 65 males, or about ¼, being in Section I (*protoneptunia*), and 4 out of 24, or ⅙ of the females.

Stages in reduction of pattern.	*Proto-neptunia.* I. As in Figs. 1-3.		*Trans-itiona'.* IA. As described in Table A and shown on Pl. XLIV, Fig. 7.		*Trans-itional.* II. As in Figs. 4-6.		*Neptunia.* III. As in Figs. 7-9.		TOTALS.
Sexes . . .	♂	♀	♂	♀	♂	♀	♂	♀	
Pl. XLIII (Hope Dep.) . . .	3				3		2	1	9
Table A. (Hope Dep.) . . .	5	2	3	1	2	1	7	2	23
Bourke Coll. and Hope Dep. .							3	1	4
Table B. (Tring Mus.) . . .	3	1	2	2	1	1	10	7	27
Table C. (Brit. Mus.) . . .	3	1	1	1	1		8	3	18
Table D. (Hill Mus.)	3		1		1		3		8
TOTALS . .	17	4	7	4	8	2	33	14	89

The greater development of mimicry in the female *neptunia* is more convincingly proved by noting the sex of the specimens which resemble or most nearly approach fig. 9, representing the most perfect mimic hitherto seen. It is a female and so is the specimen from Levuka in the Hope Department which is nearly equal to it. The four darkest specimens in Table B are females, as is one of the two darkest in Table C, all five approaching fig. 9.

In this, the most completely mimetic pattern attained by *neptunia*, it is the extent to which the hind-wing participates which becomes the chief criterion, the fore-wing having almost or entirely lost its internal pattern while much remains upon the hind. In this later stage of elimination the female has a distinct advantage over the male from the existence of sexual dimorphism—I believe hitherto unnoticed—in the species grouped by Moore under his genus *Tirumala* (P.Z.S., 1883, pp. 230–233). The characteristic V-like mark in area 2 of the hind-wing and the smaller one in area 3 are, in nearly all the species, shorter

and often vestigial in the female. The reduction in length, which is accompanied by a thickening of the remaining portion, proceeds from the distal end and often leaves only the point of the **V**. In the species with little or no shortening the female marks are still distinguished by a thickening. In *neptunia*, however, the shortening is pronounced, even in the strongly-patterned *protoneptunia* form, and, in the most perfect mimics (fig. 9), leads to the entire disappearance of the marks from both areas. But this is not the whole explanation of the more complete loss of pattern in the hind-wing of this sex. The existence of the scent-pocket in area 1c reduces the adjacent marks of the male, which are therefore in this area much longer in the female of *protoneptunia*. But these marks, together with others on the basal half of the hind-wing, disappear or become vestigial in the most completely mimetic females. And yet, as regards the marks in area 1c, sexual dimorphism gives the advantage to the male—an advantage over-ridden by female variation and the pressure of selection.

Another interesting result is the concentration of specimens at the two ends of the scale and especially in Section III, which contains over half of the total. It is probable that the examples in Sections IA and II, the transitionals bridging the gap between the extremes and making the whole series exceedingly "continuous," are in large part due to interbreeding between *neptunia* and *protoneptunia*.

The table strongly suggests that natural selection is favouring the pattern of *neptunia*, especially in the females, and perhaps also that female variation makes available for selection a larger proportion of butterflies with reduced patterns than are produced by the males.

The following table, unfortunately very limited because of the number of specimens with "Fiji" only upon them, holds out the hope that, with future material from many islands of the group, collected as Mr. Simmonds or Mr. Woodford collected it, we may be able to decide whether the proportion of females in Section III (*neptunia*) is due to natural selection alone or to natural selection aided by freer variation, also to decide whether *protoneptunia* exists as a subspecies in any of the islands.

Stages in reduction of pattern.	I. *Proto-neptunia.*	IA. *Transitional.*	II. *Transitional.*	III. *Neptunia.*
Naviti, Yasawa Is. .			1	
Viti Levu	7	3	2	17*
Ovalau or Viti Levu (Bourke) . . .				3
Ovalau	2	2	4	3
Taveuni	4	1		
Mango	1	1		

All the islands mentioned in the above table, except Taveuni and Mango, belong to the western part of the group in which the marginal patterns of the Euploeas are best developed. In Taveuni (p. 620), the most eastern of these western islands, patterns transitional towards the dark eastern forms occur as well as the others. In Mango (p. 625) the Euploeas are darker than in any part of known Fiji except Vanua Balavu. It may be significant that in this island and Taveuni the seven specimens are either *protoneptunia* or transitional, with patterns ancestral as compared with those of the great majority of the examples from the other islands in the table. More material is wanted to test this suggestion; but it is not unreasonable to suppose that the reduction of pattern, although it has produced mimicry of the western type of Euploeas, leads to no advantageous resemblance to the dark eastern type and has therefore not been selected.

H. HYPOLIMNAS BOLINA L., IN FIJI AND POLYNESIA.

Further evidence that West Fiji was, like East Fiji, inhabited by dark Euploeas is provided by a mimetic female form of *Hypolimnas bolina* which has retained the appearance now lost by its models in the west. This mimetic female is well shown in Pl. XLV, fig. 3, as well as in Pls. XLVII, fig. 4; XLIX, fig. 6; LII, fig. 3; LIII, figs. 1, 2. Its dark surface, which is almost patternless except for the submarginal series of small white spots on the fore-wing, presents a remarkably close resemblance to the dark Euploeas of East Fiji, shown on Pl. XXXI, figs. 3–8.

* No. 9 of Table C is included, as it is believed that Natova is in Viti Levu.

This mimetic female is, however, only one out of a considerable series of forms which have been described as distinct species by various authorities, especially Dr. A. G. Butler. The names can now be conveniently retained for the female forms.

The credit of the discovery that these Polynesian butterflies with so many and such different female patterns are all forms of one species, belongs to Mr. Gervase F. Mathew, F.E.S., who, on November 4, 1885, "exhibited a number of specimens of *Hypolimnas Bolina*, Linn., from Fiji and other islands of the Western Pacific. They were interesting from the fact that many of them were bred from a single brood of larvae found near Levuka. The males varied in no way whatever, but of the females, of which forty-eight were exhibited, scarcely two were alike, and the difference between the two extremes was very great. . . . From a short examination of the types at the British Museum, he felt sure that several which had been described as new within the last few years were referable to this single species, for from this brood were bred individuals agreeing with varieties from the Gilbert, Ellice, and Marshall islands, the New Hebrides, New Guinea, Tonga, Samoa, etc. The larvae were identical, fed upon the same food-plant, and were altogether similar in their habits. None of the females were found mimicking *Danais Erippus*. Mr. Mathew proposed that it might be advisable to collect these varieties together, and unite this oceanic race under one specific name." (Proc. Ent. Soc., 1885, p. xxvi.)

In addition to *bolina* an apparently allied new species of *Hypolimnas* has recently been discovered by Mr. Simmonds in Viti Levu and described as *H. inopinata* by Mr. G. A. Waterhouse in Proc. Linn. Soc., N.S. Wales, xlv (1920), pp. 468, 469. The female is larger and more highly coloured on the under surface than the male. The species is mentioned here because it is probably mimetic of the males and male-like females of *bolina*; but whether the close resemblance between the patterns is due to affinity or mimicry or both together is a subject for future investigation. *H. opinata* appears to be common where Mr. Simmonds discovered it in the rain-forests (200–500 ft.) of south-east Viti Levu,* for he wrote on January 27, 1920, of a week-end at Waidoi—"I saw about ten of the new

* Mr. Waterhouse records that a male was also taken by Mr. E. J. Goddard at Nasogoto, Navai, Fiji.

Hypolimnas, but all were badly damaged. I only took two";·and again on March 16, 1921—"The specimen came from the rain-forest above Waidoi where it was not uncommon but most difficult to catch." We may hope that the life-history will soon be made out and its true affinity discovered.

(a) *Invasion of Fiji and Polynesia by H. bolina from the West and the Changes undergone in the new Home.*

There can be little doubt that the invading *bolina* belonged to the race now inhabiting the south and south-east islands of the Malay Archipelago, and north Australia—a race whose predominant female form is generally known as *nerina* F., resembling Pl. XLV, fig. 2, but with larger white and reddish markings. The suggestion that this form arose in Celebes, as a mimic of *Danaida chionippe* Hübn., was made by the late Col. Charles Swinhoe (Journ. Linn. Soc. Lond., Zool., xxv (1896), pp. 342, 343); and no other model, except this or some allied island race near *D. malayana* Fruhst.,* is likely to be proposed for it. The difficulty remains that the model appears to be comparatively rare and is certainly restricted in range, while the mimic is extremely common and wide-ranging. It is possible, however, that the Danaine was formerly abundant in the locality where the *nerina* female was evolved, and that the acquisition by mimicry of a conspicuous type of warning pattern was advantageous to an independently distasteful Müllerian mimic (cf. pp. 647, 648), and facilitated its spread into areas far outside the range of its model. It is even possible that the model is still abundant in the original area unvisited by collectors, or that it is neglected because it is so common.

The hypothesis that the pattern was originally mimetic and has spread beyond its model gains in probability when

* Fruhstorfer regards *malayana* as a race of *D. affinis* F., but "almost worthy of specific rank" (Seitz, ix, p. 201). His experience with *malayana* supports the opinion that the Danaine model of the *nerina* female, though hitherto barely noticed, may still be abundant:—"For a decade only one male was known" and even its supposed locality, the Malay Peninsula, was doubtful. Nevertheless, he found the butterfly fairly numerous at Bangkok (*l.c.*). Fruhstorfer gives the locality of *chionippe* as Timor, and, from his description and the series of Danaines in the British Museum, it is evident that this butterfly was not the model for *nerina*, but a race with a pattern closely resembling *malayana*.

the history of the most western form of *bolina* is taken into account. In India, Burma, etc., the female is the well-known form, mimicking dark, white-bordered Euploeas with patterns of the *core* and *coreoides* type. Three of the models from South India are represented by Maj. Moulton in Trans. Ent. Soc., 1908, pl. xxxiv, figs. 1–3, 6–8. But *bolina* with this well-marked type of mimetic female has also spread a long way beyond the range of its models. It was discovered in Socotra by W. R. Ogilvie Grant in 1899 (Bull. Liverpool Mus., ii, (1900), p. 10). A small male of the wet-season form, taken between July 1900 and March 1901, in Mauritius, by Capt. J. B. G. Tulloch, exists in the British Museum Collection. I have also been informed by my friend Mr. J. A. de Gaye, F.L.S., that he took the male on the shore at Cassis, Mauritius, in December 1902, and that he gave the specimen to the late Col. N. Manders; also that the female was taken in the island six months later, at Val Ory, Moka, by M. Réynard.*

The Indian race of *bolina* was, so far as I am aware, first seen in Madagascar, in Feb. 1903, by Mr. de Gaye, who captured both male and female examples in the garden of the British Consulate at Tamatave. The specimens were given to the Carnegie Library in Mahé, Seychelles. The butterfly was then taken by Archdeacon Kestell-Cornish, now Bishop of Madagascar, in January 1911 (Proc. Ent. Soc., 1916, p. xxiii). Since that date its increase in the district where it appeared in 1911—Mahanoro, on the east coast—has been very rapid (*ibid.*, 1915, p. lxi; 1916, p. xxi). M. Charles Oberthür, who has had such a long and intimate experience of Lepidoptera from Madagascar, had never seen an example of *bolina* from the island until his brother received it from the southern area in May 1920 (*ibid.*, 1920, p. lviii).

The observations recorded above supply abundant evidence of the power to spread and increase possessed by *H. bolina*. Even more convincing is the island race†

* These three Mauritian records of *bolina* are evidently the same as those published by the late Col. N. Manders (Trans. Ent. Soc., 1907, p. 442). Capt. Tulloch's specimen in the B.M. is briefly mentioned, the date of Mr. de Gaye's male given as Feb. 1906, and a female from the Moka district (evidently M. Réynard's) stated to be in the Port Louis Museum.

† This subspecies has not been described. In the hope that

established on the Chagos Islands in the Indian Ocean, far to the north-east of Mauritius, Bourbon and Rodriguez.

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more attention will be paid to it and a search made for transitional forms and for the Euploeine model, a short description is here given.

Hypolimnas bolina euphonoides n. s.-sp.—*Female*.—The oblique white bar of the *fore-wing* either very narrow or (in one example out of three) broken up into separate small spots. An extensive, iridescent blue suffusion spreads over a broad area round the narrow oblique bar of two specimens forming, in one of them, a very prominent feature. In the *hind-wing* there is a marked development of the marginal and submarginal pattern, and the chief mark (yellowish in two examples) is prolonged, narrowing, towards the anal angle.

Male.—The two specimens in Brit. Mus. differ from the Indian males in the blackness of the general tone of the under surface, especially in the marginal area of the hind-wing.

Types: ♂ ♀ in Brit. Mus. Coll. The ♂ is No. 1 below. The ♀ (No. 5 below) resembles fig. 3 in Trans. Linn. Soc. Lond., Ser. ii, Zool., vol. xiii, pl. 17, and is probably the specimen there represented.

The effect of the above-described development of pattern in the female is to produce a striking resemblance to *Euploea euphon* F., at present only known from Mauritius. In the fore-wing this likeness is increased in one specimen by the breaking up of the oblique bar into spots. Upon the wing the area of iridescent blue would probably resemble the corresponding part of the fore-wing of *euphon*.

Prof. T. Bainbrigge Fletcher (*ibid.*, p. 291) states and Commander Walker quotes in Proc. Ent. Soc., 1919, p. cxii, that the Chagos females of *bolina* resemble those from Palawan in the Philippines. Being unable to visit the British Museum at the time I asked Capt. Riley if he would compare the females from these two localities. He has very kindly sent me the following list of the Chagos specimens, together with the results of the comparison he has made.

"1. ♂. Chagos Is. Ile Anglaise. 31.5.1905. T. B. Fletcher.

"2. ♀. " " " "

"3. ♂. " 'J.S.G.' (in MS. J. Stanley Gardiner), no date. T. B. Fletcher.

"4. ♀. Chagos Is. Ile Boddam. 3.6.05. T. B. Fletcher.

"5. ♀. " Peros Banhos, Ile du Coin, 25.6.05. T. B. Fletcher.

"All 3 ♀♀ from Chagos Is. have the submarginal white dots well developed, Nos. 2 and 4 much as in Palawan ♀♀, No. 5. larger than in Palawan ♀♀. The transverse white band just beyond cell of F.W. is very variable—as in Palawan ♀♀. The H.W., however, is much paler than in any Palawan specimen we have, the white discal patch being produced towards anal angle so as to form quite a distinct band rather than an oval patch."

The differences described by Capt. Riley, and especially the band-like modification of the chief H.W. mark, are such as to promote strongly the resemblance to *euphon*.

Prof. T. B. Fletcher states (*ibid.*, pp. 290, 291) that altogether 14 ♂♂ and 5 ♀♀ were taken in the Chagos group, and he quotes the

This race must have reached these islands long ago, for the female form is different from any other in the known range of *bolina*, being an evident mimic of *Euploea euphon* F., now only known in Mauritius, but mimicked by the female of *Papilio phorbanta* L. in Bourbon,* and therefore formerly a resident in that island. A glance at the map of the Indian Ocean at once suggests that this Oriental *Euploea* and *E. mitra* Moore, of the Seychelles, reached their present localities by way of the Laccadive, Maldive, and Chagos groups and the islands between them; thence westward and south-westward by many other scattered islands. The route of the invading *euphon* clearly passed through the Chagos Group, and it is not an extravagant exercise of the imagination to see in the race *bolina euphonoides* the persistent effect of its residence in these islands. It is but an extension of the hypothesis advanced by Col. Manders to account for the phenomena in Bourbon, although he also suggested a special cause for the model's disappearance, viz. the accidental introduction by the sugar-planters of the competing *Euploea goudoti* Boisd.

It is possible that *euphon* still exists in some of the immense number of islands referred to above, or it may be that it has now disappeared after a residence long enough to have acted as the model for the female *bolina* in the Chagos Islands. Dr. G. C. Bourne, F.R.S., states that the greatest elevation reached in Diego Garcia is from 25 to 30 ft. (P.Z.S., 1886, p. 331), indicating conditions which, as in the Pacific, may be unfavourable to the permanent residence of a *Euploea*, but not to *H. bolina*. But the

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following localities: Salomon Atoll, Peros Banhos, Diego Garcia and Egmont Atoll.

Commander Walker (*l.c.*) speaks of Dr. G. C. Bourne's captures of *H. bolina* in Diego Garcia, but although this species is included in the list of butterflies in P.Z.S., 1886, p. 333, I have no doubt that *H. misippus* L. was intended. The two names have often been confused; and the male butterfly presented to the Hope Department by Dr. Bourne is *misippus*. It was taken Dec. 22, 1885, and the captor remembered that it was pursuing a butterfly with a very different appearance, evidently the mimetic female. It is an addition to the species hitherto recorded from the Chagos Is.

* Also mimicked by *Salamis augustina* Boisd., formerly known to exist in Mauritius and still to be found, although very rare, in Bourbon. For this and the mimicry of *Pap. phorbanta*, female, see Proc. Ent. Soc., 1908, pp. iv–vii, xlii–xliv and references there given.

great need is further careful investigation of these islands, an investigation almost certain to throw further light on the Chagos race of *bolina*, even if its model has now entirely disappeared from the track by which it reached the western side of the Indian Ocean.

Returning to the invasion of Fiji and Polynesia by *H. bolina* with a predominant female of the *nerina* form, it will be found that in Australia, and wherever *nerina* occurs in the Malay Archipelago and the associated island groups, the amount of "*nerina* red" in the fore-wing of the female varies greatly in extent and in tint, passing usually from red to orange as it covers a larger and larger area; furthermore, that the chief mark of the hind-wing is often bordered externally with orange, the amount varying from a narrow to a very broad edging, occasionally passing inwards and replacing the white patch. A female form in New Caledonia, with great extension of orange in the fore-wing and, in the hind, of the white patch, with a broad border of orange externally, narrow basally, was described by Dr. A. G. Butler as *pulchra* (P.Z.S., 1874, p. 281, pl. xliv, fig. 2). Its pattern, as suggested by the author, resembles the *alcippus* form of *D. chrysippus*, and it helps us to understand the origin of the mimetic female in the closely allied *H. misippus* L. It is possible that *pulchra* may have gained some advantage by its very rough resemblance to *D. petilia*. However this may be, there is little doubt that in Fiji and Polynesia a further great development of orange, starting from a form resembling *pulchra*, led to the most remarkable of all known female forms of *bolina*, viz. the orange or yellow, occasionally nearly white, female named *pallescens* Butl. (Pl. L, figs. 1, 2), well known in Fiji, the Friendlies, and probably some other Polynesian groups. But we are also obliged to assume that *nerina* itself was present as an invader, for in all parts of Polynesia traces of the "*nerina* red," and sometimes the complete pattern, although in a somewhat reduced form, are liable to appear.

No Euploeine model, except the forms of *helcita* (p. 580), is known, and probably no other has ever existed, in the great majority of the Polynesian groups, and we find that the females of *bolina*, as they spread eastward, tend to lose their polymorphic forms and resemble the male pattern, a tendency especially marked in the Societies. But even

here *nerina*-like forms exist. The first few Tahitian examples received from Mr. Simmonds were male-like (Proc. Ent. Soc., 1920, pp. lxxii–lxxv), but a later and much larger consignment of bred specimens included several with the reduced *nerina* pattern.

In Fiji, with four species of *Euploea*, it has already been stated (p. 639) that there is a beautifully mimetic female * *bolina*, probably derived, by suppression of markings, from one of the male-like forms.

All the female forms of *bolina* in Fiji and Polynesia may, I believe, be classified in three sections :—

A. Non-mimetic forms derived from the *nerina* pattern, either directly, or more commonly by a continuation of the changes begun in *pulchra*.

B. Male-like forms.

C. The mimetic *euploeoides* derived from a male-like form.

It will also be shown that the forms in one section commonly exhibit traces of patterns which fall into another section. The attempt to carry the classification further under heads A and B, with full references to the coloured plates, will be found on pp. 652, 653, in the part of this memoir which describes the families of *bolina* bred by Mr. Simmonds.

(b) *The Life-history and Habits of H. bolina in the Pacific, discovered by G. F. Mathew and J. J. Walker.*

The beautiful plate (XLV) representing the life-history of the Fijian *bolina* has been reproduced from a coloured

* I propose the name *euploeoides* for this mimetic Fijian form which may perhaps be found in other Pacific islands where *E. boisduvalii simmondsi* occurs, or formerly existed.

Euploeoides n. female f.—Characterised by the suppression of the chief marks, the obscurity of the marginal pattern, and the retention, in the fore-wing, of the series of small submarginal white spots, parallel with the outer margin, and culminating in two subapical spots, of which the first is much larger than the others and the second (nearest to the costa) rather larger.

It will be observed that this mimetic pattern has been entirely evolved by suppression or reduction of markings.

Type ♀, No. 2 (p. 661) in all-female Family 7, of female parent W. from Kandavu, Fiji. Hope Dept., Oxford University Museum.

This female form is very liable to exhibit traces of the patterns of other forms. It is represented pure on Pl. XLV, fig. 3; combined with a trace of "*nerina* red" on Pl. LIII, fig. 2; of orange margin on Pl. LII, fig. 3; of chief marks, fuscous on F.W., blue on H.W., on Pl. XLVII, fig. 4; of the F.W. mark alone on Pl. XLIX, fig. 6.

drawing kindly lent to me by Mr. Gervase F. Mathew. "It was," as he has written, "difficult work having to do my painting on the ward-room table of a small ship, where the light was often very bad, and interruptions frequent. My own cabin was far too dark. The two females are figures of the most common form of that sex. I think they were about equally numerous."

Mr. Mathew has also kindly looked through his notes * made at the time, showing that he captured or observed the butterfly or its larvae in the following Pacific islands in addition to Fiji :—

Funafuti, Ellice Islands, May 29, 1883—larvae.

Matthew I., Gilbert Group, June 9, 1883—larvae.

Pitt I., Gilbert Group, June 10, 1883—the only butterfly seen, also larvae.

Majüro I., Marshall Group, June 16, 1883—the only butterfly seen.

Jaluit, Marshall Group, June 19, 1883—butterfly abundant and larvae numerous.

Kusaie, Caroline Islands, June 28, 1883—butterfly plentiful at Kusaie and Ponapé.

Norfolk I., May 28, 1884—*bolina* present in a collection received from the island.

Apia, Samoa, June 20, 1884—many *bolina* : the females varied a good deal. Also at Pango Pango, June 26.

Tonga, July 7 and 8, 1884—*bolina* noted on both days, in great numbers on the 8th.

Ne afo, Vavua I., Tonga Group, July 18, 1884—*bolina* plentiful and the females varied excessively.

"For some of the islands visited I made no note as to whether it occurred or not, though I am pretty sure it did. —G.F.M."

Mr. Mathew has also kindly summed up his experience of *H. bolina* in the Pacific in these words :—"*Bolina* was the commonest and the most widely spread butterfly among the islands of the Pacific I visited. It was a great favourite of mine, and was a very fearless insect. In the heat of the day they were fond of hiding themselves on the

* These notes were in part published by Mr. G. F. Mathew in Trans. Ent. Soc., 1888, pp. 149–151, together with an account of the habits and life-history of the Polynesian *H. bolina*. It is there recorded that the egg is yellow and that the larva feeds on two species of *Sida* and "a convolvulus"; also, as Mr. Mathew believed, on "various species of *Portulaceae*."

undersides of leaves by the sides of the footpaths through the woods, and when one passed they would dash out almost into one's face. When sitting feeding on flowers the females were so tame they would almost allow one to stroke them—but the males were more wary."

Commander Walker, who has also had a very wide acquaintance with this butterfly in the Pacific and has published many notes on it in the Entomologist's Monthly Magazine, has read Mr. Mathew's account and tells me that it entirely describes his own experience. The habits, as observed by both naturalists, strongly suggest that the butterfly is specially protected, and that the *Euploea*-like female is a Müllerian mimic. This conclusion receives further support in the migration of the mimetic forms of *bolina* into areas far removed from their Euploeine or Danaine models and their rapid increase and predominance in these areas (pp. 641, 642).

Mr. G. F. Mathew was on H.M.S. "Espiegle" at Fiji, when he first found the larvae of *bolina* in a valley near Levuka, Ovalau, on June 13, 1882. He has kindly extracted the following note from his journal, referring to that date: "I noticed plenty of *D. erippus* [*plexippus*], together with their larvae; *D.* [*H.*] *bolina* and I believe their larvae, for I discovered a spiny larva somewhat similar to that of *A. aglaia* feeding in plenty upon an unknown shrubby plant."

On the following day Mr. Mathew observed that these larvae "seemed to be somewhat crepuscular in their habits, for I noticed that they ascended their food-plant and became much more conspicuous towards sunset. I boxed a couple of dozen of the largest ones and also 2 pupae which I found hanging low down on the plant." On June 22, at Aneiteum, in the New Hebrides, a male *bolina* emerged from a pupa of which the larva had been collected in Fiji, thus proving the correctness of Mr. Mathew's surmise.

The food-plant was "a common little shrubby-looking plant with yellow flowers which grew in clumps along the beach just beyond high-water mark." Mr. Mathew afterwards found the larvae feeding on allied plants with similar habits, at Funafuti, Matthew I., Pitt I., and Jaluit, Marshall Islands.

I submitted the coloured drawing of the plant, reproduced on Plate XLV, to my friend Dr. O. Stapf, F.R.S., of Kew.

He kindly wrote, October 20, 1923: "It is no doubt a *Malvacea* and very probably a species of *Sida*. Beyond that I would not go. There are very many species of *Sida* spread all over the tropics, and not a few are regular weeds which may turn up anywhere. There are few *Sidas* recorded from Fiji, and they are distinct from your plant; nor have I found any specimens in our Malayan and Indian covers to match the drawing."

The Botanical Department of the Natural History Museum was next consulted and, with the kind help of Dr. A. B. Rendle, F.R.S., and Mr. E. G. Baker, the plant was identified as *Sida fallax* Walp., although the herbarium specimen which agreed with the drawing was not from Fiji but another Pacific group. It appears that collectors of plants often adopt the same procedure as that of many entomologists, and neglect the most interesting and successful species, because they are the commonest! All my botanical friends agreed that the number of petals (which should have been five), shown on Pl. XLV, was due to inadvertence or to the fact that the drawing was made from an exceptional variety.

Commander Walker discovered the larvae at Fatouhiva, Marquesas Islands, March 10–11, 1883 (E.M.M., Vol. 20, 1883–4, p. 92), only a few months after Mr. Mathew, and he has kindly allowed me to make use of the unpublished description in his journal. It was written with the living larva before him within three months of his first sight of it. In this period he had also made its acquaintance in Tahiti and Eimeo (Societies) and in Aitutaki (Cook Is.).

"General aspect that of a *Vanessa* or *Argynnis* larva. Length from 1¾ to more than 2 inches: cylindrical, rather stout, a little attenuated in front. Head a little larger than 2nd segment, deeply bifid at top, and bearing, on each lobe, a long, blackish spine pointing upwards and a little forwards: colour light reddish-brown or burnt-sienna. Body deep brownish-black, with a rather well-defined, irregular, subspiracular, longitudinal stripe on each side, light burnt-sienna colour: legs and prolegs of the same tint. Segments 3 to 12 bear eight ochreous-orange, slightly branched spines about ⅙ inch long, rigid and somewhat irritating when handled: segment 2 has only two short spines on either side. Spiracles black, surrounded with ochreous-yellow. Specimens from Aitutaki are much suffused with ochreous-brown.

"Feeds on a common weed (of the order Malvaceae), with nettle-shaped leaves and small yellow flowers.

"Pupa not very unlike that of *Vanessa io*, but larger and stouter: palpi-cases rather distinct, front of thorax very convex, with a strong, toothed, lateral crest. Abdomen very stout and rather abruptly truncated, bearing 5 longitudinal rows of sharp-pointed tubercles, the outer ones only distinct on the anterior segments. Anal appendage rather short and stout. Colour dark, dull, umber-brown, irregularly blotched with a lighter and more ochreous tint, especially on the wing-cases.

"It remains in the pupal state rather less than a fortnight."

Commander Walker at once recognised the Fijian larva, drawn by Mr. G. F. Mathew (Pl. XLV), as similar to the form in Aitutaki: those from further east in the Marquesas and Societies were much darker.

The colour differences between larvae from different localities is very interesting and has been insufficiently studied. Trusting to memory, I believe that the larvae of *Pyrameis atalanta* L., found feeding on Mallow as well as nettle at Tenerife in March 1888, were far more commonly of a cream-colour than they are in England—a difference perhaps analogous to that of *H. bolina* in different parts of the Pacific, the two butterflies being closely allied, as a glance at the larvae and pupae on Pl. XLV will suggest. The colour differences between the two pupae drawn by Mr. Mathew are probably due to a susceptibility to their surroundings, such as is known to exist in certain Vanessidae and at least one Argynnid.

Mr. H. W. Simmonds informs me that in Fiji the eggs are green or yellow, but not so deep a yellow as those of *Hypolimnas antilope*. Two females bred from green eggs taken on Vanua Balavu are male-like forms, with predominant white on the chief marks; two from yellow eggs found on the same island are the mimetic *euploeoides* form, with the chief mark of the hind-wing indicated by a blue iridescence. The association of the female forms with the colours of the eggs is probably accidental, but it would be interesting to repeat the experiment on a large scale.

(c) *Families of H. bolina, Bisexual and All-female, Bred from known Female Parents from different Fijian Islands, by Hubert W. Simmonds.*

Mr. Simmonds' notes on the number of the all-female families bred by him and the prevalence of females in the Suva district have been published in Proc. Ent. Soc., 1923, pp. ix–xii. Mr. G. F. Mathew has also written on the same subject :—

"I must have bred several hundred, and of course a number were given their liberty. I remember that the females were greatly in excess of the males, as they were in the various localities where they occurred."

The following extracts from Mr. Simmonds' letters describe his attempt to determine, for Taveuni, the proportions of the sexes and of the female forms, by the only really satisfactory method.

March 24, 1922.—"Whilst away I endeavoured in Taveuni, where *bolina* is abundant,* to pick up as many larvae as possible and breed them out, thus showing the average of the various forms to some extent, which cannot be done otherwise, as collecting is always selective. I am now breeding these, and hope to forward all males and females by the next mail."

April 10, 1922.—"I had bad luck in regard to my larvae of *H. bolina* which I had picked up in Taveuni, ants clearing off all that had not pupated (some 50 or 60) one night; so I now send the few that emerged, and all these are dark. Doubtless this is the prevailing type in Taveuni."

Before recording the families of *bolina* bred by Mr. Simmonds it is necessary to attempt to classify the female forms. All the forms included in the seven Fijian families appear in the table on pp. 652, 653, together with a reference to the figure or figures on the coloured plates by which each form is represented. Mr. Simmonds' success has been so great that I believe nearly every form in Fiji and Polynesia will be found figured on Plates XLVI–LIII. The exceptions are chiefly transitional forms, other than the many here represented, and also races distinguished, like that from the Societies, by the colour of the under surface.

In the western race of *bolina* from continental India the seasonal differences are well marked, and are retained by

* Mr. Simmonds also wrote on Jan. 2, 1922, of the abundance of *bolina* in this island.

the invaders into Madagascar (Proc. Ent. Soc., 1915, p. lxi; 1916, p. xxi). The dry-season specimens of both sexes are larger with the under surface pattern blurred and lacking the conspicuous white markings of the wet season. The markings exist, but in a very reduced and obscure form. Furthermore, on the male upper surface, the chief marks, especially of the hind-wing, are bluer, often entirely blue, in the dry season, while, in the wet, they consist of a large white patch which is merely encircled with blue. In Fiji and Polynesia these characters exist, but are not regularly correlated as they are, for example, in India. It is interesting, however, to note that of the male-like females (B) in the following table, one group (I) possesses this last-mentioned feature of the wet-season male, the other (II) that of the dry.

Fijian and Polynesian Female Forms of H. Bolina.

A. NON-MIMETIC (in Fiji and Polynesia).

I. *Nerina*-like (= *elliciana* Fruhst.). Resembling the ♂-like ♀ form B.I., but with the addition of a conspicuous red or orange patch in areas 1B, and 2 of F.W. (LIII,* 3); often also invading 1A (XLV, 2). Traces of this mark ("*nerina* red") often occur combined with other patterns (XLVI, 3, 4: LI, 4: LIII, 2).

II. Wings bright orange or yellow, dark at the bases.
   (a) *Chief mark white and prominent on F. and H.W.* (= *pallescens* Butl.—L, 1, 2).
   (b) *Chief mark obsolescent or absent* (L, 3).

III. Wings dusky orange, dark at the bases.
   (a) *Chief mark of F.W. white* (XLVIII, 2; XLIX, 2, 3, 4; LI, 1, 2).
   (b) *Chief mark of F.W. orange* (XLVIII, 1, 3; XLIX, 1; L, 4; LI, 3).

IV. Dark wings bordered with orange chiefly developed at apex of F.W.
   (a) *Chief mark of F.W. white* (= *montrouzieri* Butl.—XLVII, 2).
   (b) *Chief mark of F.W. orange* (XLVII, 1; LI, 4).

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* "Pl." and "fig." are omitted from the references in this table.

B. MALE-LIKE.

I. White predominant in chief mark of H.W. Blue, if present, restricted to border (= *naresi* Butl.—XLVI, 4; XLVIII, 4; LIII, 4).

II. Blue strong or predominant in chief mark of H.W.

(a) *Chief mark of F.W. white and conspicuous* (= *thomsoni* Butl. *and* *moseleyi* Butl.—XLVII, 3; XLIX, 5; LII, 1).

(b) *Chief mark of F.W. obsolescent; pattern transitional to euploeoides* (p. 646 note—XLVI, 1, 3). Here also comes *murrayi* Butl. (XLVI, 2; LII, 2).

C. MIMETIC.

Dark and nearly patternless except for the submarginal white spots of F.W. The female form *euploeoides* (XLV, 3; XLVII, 4; XLIX, 6; LII, 3; LIII, 1, 2).

Before describing the bred families of *bolina* it will be convenient to give references to the descriptions of Brit. Mus. types included in the table, and to clear up, as far as possible, the uncertainty which prevails as to the locality of some of them.

Elliciana, described by Fruhstorfer as a "very small, melanotic form" from the Ellice Is. (Seitz, ix, 553), resembles LIII, 3. *Type*: ♀.

The ♀ type of *pallescens* is labelled "Solomon Islands," evidently in error. It is briefly described and figured, as a var. of *bolina* from the "South-sea Islands," by Butler in Brenchley's "Cruise of the Curaçoa," 1873, p. 468, pl. xlviii, figs. 3, 4. Two examples are stated to exist, in British and Maidstone Museums. The name *pallescens* first appeared, with a reference to the previous description and figures, in Butler's paper P.Z.S., 1874, p. 282, No. 47, where the erroneous locality is given. The cruise had included Polynesia and Fiji, and there is no doubt that the specimens came from either one or the other—almost certainly the latter.

Montrouzieri Butl. (P.Z.S., 1874, p. 281). *Types*: ♂, New Hebrides; ♀ "Navigators Island" (sic). The ♀ type, with three other ♀ *bolina* similarly labelled, was recorded in 1851 as part of a collection said to come from this locality, and received at some earlier unknown date; but the specimens certainly have nothing to do with the "Navigators' Islands," an old name for the Samoan

Group. The Samoan *bolina* are very small, and these very large for Polynesia. There is no doubt that they are correctly placed with specimens from the Cook Is. (Rarotonga, etc.) in Brit. Mus. Coll.

Naresi Butl. (Ann. Mag., Nat. Hist., Ser. 5, vol. xi, p. 414). *Types*: ♂ ♀, Tongatabu.

Thomsoni Butl. and *moseleyi* Butl. (Ann. Mag. Nat. Hist., Ser. 5, vol. xi, p. 414). *Types*: ♂ *thomsoni*, ♂ ♀ *moseleyi*, Tongatabu; ♀ *thomsoni*, Kandavu, Fiji. Both have ♂-like ♀♀ with differences of pattern which, for such a variable species, are very slight. *Thomsoni* stands, as it is described earlier on the same page. Fruhstorfer quotes this form, named in honour of the great naturalist of the "Challenger" who moved *Peripatus* into its true sub-kingdom,—*morseleyi!* (Seitz, ix, p. 553).

Murrayi Butl. (Ann. Mag. Nat. Hist., Ser. 5, vol. xi, p. 413). *Types*: ♂ ♀, Kandavu.

The following seven families are arranged in the order already adopted for the Fijian islands (pp. 611–627), beginning with Viti Levu.

FAM. 1.—*Small all-female family of female parent Z, captured at Suva, July* 1921.

(Plate XLVI. Nat. size.)

The female parent, which is much worn, especially in the fore-wings, resembles fig. 3. It is a dark form which still retains indications of the central blue iridescence of the hind-wing and the white submarginal spots of the fore. The under surface is also apparently very similar. The specimen shown in fig. 3 was marked "as parent" by Mr. Simmonds.

The family contained five females, one of which, resembling the parent and therefore like fig. 3, was retained by Mr. Simmonds.

Four out of the five—figs. 1–3 and the last-mentioned female—are the mimetic *euploeoides* form combined with elements from other patterns: fig. 1, with the chief markings blue, those of the hind-wing resembling the form *thomsoni*; fig. 2, with the added elements much obscured, resembles *murrayi*; fig. 3, with slight blue patch in hind-wing, also exhibits traces of "*nerina* red" in fore-wing. The female represented in fig. 4 is the male-like female *naresi* but with emphasised white patches and a trace of the "*nerina* red."

The specimens emerged in the following order :—

Aug.	5.—The female represented in fig.			4
,,	6.	,,	,,	,, 3
,,	8.	,,	,,	,, 2
,,	9.	,,	,,	,, 1

It is noteworthy that the form represented in fig. 1 possesses the chief marks of the male dry-season form, fig. 4 the chief marks of the wet, but over-emphasised.

In the following families the offspring which most closely resemble the form of the female parent are placed first and the remainder in a series which departs further and further from her pattern, thus following the arrangement of Plates XLVII–LIII. Hence Patterns A, B, C, etc., do not correspond in the different families; for A always represents the nearest approach to the female parent, and these parents differ widely from one another. Each pattern is, however, brought into relation with the table on pp. 652, 653.

Fam. 2.—*All-female family of female parent Y, captured at Suva, July* 9, 1921.

(Plate XLVII. Nat. size.)

The female parent, which is much worn, resembles fig. 1. It is near the form *montrouzieri*, which, however, has the fore-wing oblique bar white and more extensive blue in the centre of the hind-wings, in both respects resembling fig. 2.

The family is divided into the forms represented on Pl. XLVII, as follows. The year 1921 is of course to be understood for the emergences.

Family.

Pattern A.

1.—Female shown in fig. 1: emerged Sept. 2, 1921 (omitted below).

2.—Female resembling fig. 1: emerged Aug. 28. ("Y. 1.").

3. ,, ,, ,, ,, Aug. 29.

4. ,, ,, ,, ,, Aug. 30.

5. ,, ,, ,, but without orange and nearly without blue in centre of hind-wing: emerged Aug. 28. ("Y. 1. Intermediate.")

6.—Female like No. 5: emerged Sept. 2.

Pattern B.

7.—Female shown in fig. 2: emerged Aug. 29. ("Y. 1.")

This is the form *montrouzieri*, but with less development of orange than in the type.

8.—Female resembling fig. 2: emerged Aug. 27. ("Y. 1.")

Pattern C.

9.—Female shown in fig. 3: emerged Aug. 30.

This appears to be the form *naresi* in the fore-wing, and *thomsoni* in the hind.

10.—Female resembling fig. 3: emerged Aug. 30.

11. ,, ,, ,, but with less blue in hind-wing centre: emerged Aug. 31.

Intermediate between C and D.

12.—Female resembling fig. 3, but oblique fore-wing bar clouded over with scattered dark scales: emerged Aug. 28. ("Y. 3.")

This approaches the form *murrayi*, but the markings are more reduced.

13.—Female like No. 12: emerged Aug. 30.

Pattern D.

14.—Female shown in fig. 4: emerged Aug. 30.

This also approaches the form *murrayi*, but with pattern still further reduced. It is seen to be the *euploeoides* mimetic form with traces of the *murrayi* pattern added.

15.—Female like No. 14: emerged Aug. 28. ("Y. 3. As 2, but darker.")

Mr. Simmonds retained for breeding three females, one of each of the three types "Y. 1," "Y. 2," and "Y. 3" intended to be indicated on some of the specimens. Unfortunately "Y. 2" was accidentally lost in manipulation, or omitted, probably from Pattern B, "Y. 1" being inadvertently written on specimens of the latter. The fact that No. 5 is labelled "intermediate" supports this interpretation. It is possible, however, that "Y. 2" was intended for Pattern C. The label on No. 15 probably indicates that it was similar to the second specimen (No. 12) of Y. 3, but darker. We can only conclude that, of the three additional specimens, one had Pattern A or B, one Pattern B or C, one Pattern D or intermediate between it and C.

The family gives approximate equality between the presence and absence of the orange-brown colour.

One of the females retained by Mr. Simmonds laid sixty or seventy parthenogenetic eggs, but all were infertile.

This family was somewhat larger than the above numbers indicate, for Mr. Simmonds wrote on Sept. 10, 1921—" In the three biggest families I have retained the last few to emerge irrespective of which form they took." The two other families to which these words apply are apparently 6 (X) and 7 (W).

FAM. 3.—*Bisexual family of female parent K, captured in Ovalau, May* 6, 1922.

(Plate XLVIII. Nat. size.)

The worn female parent, represented in fig. 1, appears to be intermediate between the offspring represented in figs. 2 and 3.

The family, following the order of the female forms on Pl. XLVIII, is as follows :—

FAMILY.

Pattern A.

1.—Female shown in fig. 2: emerged June 13, 1922 (omitted below).

2.—Female resembling fig. 2: emerged June 9.

Pattern B.

3.—Female shown in fig. 3: emerged June 9.

Pattern C.

4.—Female shown in fig. 4: emerged June 11.
This is the form *naresi*, with emphasised white patches.

5.—Female resembling fig. 4: emerged June 11.

6. " " " " " 15.

7. " " " " " 15.

8.—Male emerged June 14.

Three females of pattern A or B and one of C were retained by Mr. Simmonds for breeding.

It appears that the intermediate pattern of the female parent has split up into its constituents A and B; the two together give as near equality as possible with pattern C (6 to 5).

Fam. 4.—*All-female family of female parent O, captured in North Vanua Levu, Sept.* 18, 1922.

(Plate XLIX. ¾ Nat. size.)

The female parent, taken on the road from Naduri to the Dreketi (Ndrekati) River, in the Macuata district, is very much damaged, but evidently resembled fig. 1.

The female forms in the family are tabulated below. All emerged in November, 1922, the actual date of No. 5 being Nov. 5, and Nos. 1 and 7—Nov. 6.

Family.

Pattern A.

1.—Female form shown in fig. 1.

2, 3, 4.—Female forms resembling fig. 1.

B. Transition from A to D.

5.—Female form shown in fig. 2.

6, 7.—Female forms resembling fig. 2.

C. Further step to D.

8.—Female form shown in fig. 3.

Pattern D.

9.—Female form shown in fig. 4.

10. „ „ resembling fig. 4.

Pattern E.

11.—Female form shown in fig. 5.
Female form *naresi*, but with more blue near F.W. costa and rather larger H.W. patch.

12, 13.—Female forms resembling fig. 5.

14, 15. „ „ „ „ but with H.W. patch larger and the white more extended.

Pattern F.

16.—Female form shown in fig. 6. The *euploeoides* female costa with a trace of the *murrayi* pattern in F.W.

17, 18, 19, 20.—Female forms resembling fig. 6.

Mr. Simmonds retained six females—"2 dark, 2 yellow with white circles, and 2 without." We may therefore safely add two to Pattern A, two to C or D, and two to E or F.

There is here approximate equality between the female forms with orange invasion and those without; also fair equality between the four classes represented by fig. 1 (6),

figs. 2–4 (8), fig. 5 (6), and fig. 6 (6), respectively, allowing for the addition of two of the retained females to the first class, two to the second, and one each to the third and fourth.

The relation between the patterns is very different. There is a beautiful transition from A (fig. 1) to D (fig. 4), but a sharp break between D and E (fig. 5), and between E and F (fig. 6). The uniformity of F is very interesting. Nos. 16–20 all bear the mimetic *euploeoides* pattern, but all retain a blurred trace of the subapical oblique bar of the fore-wing.

FAM. 5.—*Bisexual family of female parent S, captured in Taveuni, Sept.* 4, 1921.

(Plate L. Nat. size.)

The female parent, represented in fig. 1, is the form *pallescens*. The family emerged in October 1921, during Mr. Simmonds' absence. No. 5, a bred specimen with the date of emergence Oct. 29, is included in the family, although it does not bear the letter "S," probably inadvertently omitted.

FAMILY.

Pattern A.

1.—Female form shown in fig. 2 (*pallescens.*)

2, 3.—Female forms resembling fig. 2.

4, 5. „ „ „ „ , but with smaller chief marks on F. and H.W.

Pattern B.

6.—Female form shown in fig. 3.

7, 8, 9, 10.—Female forms resembling fig. 3, but two (8, 9) have very slightly darker orange ground-colour, and another (10), with the dark basal areas emphasised in extent and depth, has a trace of a blue and white chief mark on H.W.

Pattern C.

11.—Female form shown in fig. 4.

12. „ „ resembling fig. 4 and like it with the faintest trace of the blue and white H.W. mark.

13.—Female form like fig. 4, but with a distinct blue and white H.W. mark, intermediate between that of figs. 2 and 4, and an emphasised F.W. oblique bar.

14–22.—Nine males.

The widespread orange ground-colour, seen in the whole of the female offspring, strongly suggests Mendelian heredity. The break between patterns A and B is sharp, although there is some slight indication of transition in No. 10. Patterns A and C are, as regards the pattern, connected by No. 13, but there is a wide difference in the ground-colour.

FAM. 6.—*Bisexual family of female parent X, captured in Kandavu, July* 25, 1921.

(Plates LI, LII. Nat. size.)

The female parent of this extremely interesting family is represented on Pl. LI, fig. 1, and, although much worn, clearly resembles the daughter shown in fig. 2.

FAMILY.

Pattern A.

1.—Female shown on Pl. LI, fig. 2: emerged Sept. 10, 1921 (omitted below).

2.—Female resembling Pl. LI, fig. 2: emerged Sept. 10.

Pattern B.

3.—Female shown on Pl. LI, fig. 3: emerged Sept. 11.

4. „ resembling Pl. LI, fig. 3: emerged Sept. 9.

Pattern C.

5.—Female shown on Pl. LI, fig. 4: emerged Sept. 11. This is near the form *montrouzieri*.

6.—Female resembling Pl. LI, fig. 4: emerged Sept. 12. Darker than fig. 4. Without H.W. patch, and the oblique F.W. orange bar is much obscured. Date believed to be Sept. 12, but the figures indistinct.

Pattern D.

7.—Female shown on Pl. LII, fig. 1: emerged Sept. 10. The female form *thomsoni*.

8.—Female resembling Pl. LII, fig. 1: emerged Sept. 9.

Pattern E.

9.—Female shown on Pl. LII, fig. 2: emerged Sept. 11. The female form *murrayi*.

Pattern F.

10.—Female shown on Pl. LII, fig. 3: emerged Sept. 11.
The female form *euploeoides* with orange and white marginal pattern.

11.—Female resembling Pl. LII, fig. 3: emerged Sept. 11.

12.—Male shown on Pl. LII, fig. 4: emerged Sept. 9.

13, 14.—Males resembling Pl. LII, fig. 4: emerged Sept. 9 and 10.

There is an extraordinary regularity about the female forms in this family, two examples of each pattern being present, except of E which is transitional between D and F. There is also as near equality as possible between the orange-suffused forms (Pl. LI) and the others (Pl. LII, figs. 1–3).

The family included five additional females.

FAM. 7.—*All-female family of female parent W, captured in Kandavu, July* 25, 1921.

(Plate LIII. Nat. size.)

The female parent, resembling fig. 1, is the *euploeoides* mimetic form.

FAMILY.

Pattern A.

1.—Female shown in fig. 1: emerged Sept. 13, 1921 (omitted below).

2.—Female resembling fig. 1: emerged Sept. 11.* Type of ♀ *f. euploeoides.*

3. „ „ „ „ „ 12.

Pattern B.

4.—Female shown in fig. 2: emerged Sept. 12.

5. „ resembling fig. 2: emerged Sept. 13.
With slightly less of the "*nerina* red" on F.W.

6.—Female resembling fig. 2: emerged Sept. 11.
With slightly more of the "*nerina* red."

* The date is written 11.x.1921, evidently intended for 11.ix.1921.

Pattern C.

7.—Female shown in fig. 3: emerged Sept. 12.
The form *elliciana*—a *nerina* with reduced pattern.

8.—Female resembling fig. 3: emerged Sept. 22.						
9.	„	„	„	„	„	12.
10.	„	„	„	„	„	12.
11.	„	„	„	„	„	12.
12.	„	„	„	„	„	10.
13.	„	„	„	„	„	13.
14.	„	„	„	„	„	13.

Pattern D.

15.—Female shown in fig. 4: emerged Sept. 11.
The female form *naresi*, with emphasised H.W. mark.

16.—Female resembling fig. 4: emerged Sept. 13.

There is equality between Pattern C (fig. 3) and the other forms taken together. The transition of the "*nerina* red" of the fore-wing (fig. 3) through Pattern B, into the black mimetic form (fig. 1) is extremely gradual, one specimen out of the three having rather more red and one rather less than is shown in fig. 2.

This was the only family out of the seven in which the predominant female of the original invader from the west, made its appearance, and then in the reduced Polynesian form *elliciana* (fig. 3).

I. HYPOLIMNAS ANTILOPE CRAM. MAY PROBABLY SUPPLY EVIDENCE THAT DARK EUPLOEAS FORMERLY EXISTED IN WEST FIJI.

The short series of this species received from Mr. Simmonds suggests the probability of further evidence that West Fiji was inhabited by dark Euploeas in the recent past. Of the three females, beautiful mimics of an almost patternless *Euploea*, one was taken in Thithia on August 31, 1921, and two in Vanua Balavu on the following day. They are dark brown butterflies with a paler tint forming a wide border to the hind-wing, and over the site of the oblique subapical bar of the fore-wing. A submarginal series of small white spots is present on both wings. For these three females the *simmondsi* race of *Euploea boisduvalii* is a convincing model, especially the forms with white spots, like that represented on Pl. XXXI, fig. 3, of

which the original came from Vanua Balavu and was taken on the same day as the two female *antilope*.

Of the three males of this *Hypolimnas*, one was captured with the two females in Vanua Balavu, the second bred, December 19, 1921, from a larva found on the same island,* the third, taken at Vunilagi, on the north-east of Vanua Levu. The first-mentioned male is considerably lighter in tint than the females, this being true of the general surface as well as the paler areas. It closely resembles Butler's figure of the type of his *lutescens* (= *antilope*) from Ovalau, in P.Z.S., 1874, pl. xliv, fig. 3. In spite of its lighter tint, this form of *antilope* is an obvious *Euploea* mimic with an especially suggestive likeness to a worn and faded model. The second, the bred specimen, differs from the first in its rather deeper shade of brown and paler pattern, especially in the fore-wing, where the oblique bar is prominent, being white overspread with scattered brown scales. It is possible that artificial conditions may have had some effect upon this specimen.

The third male is exceptionally interesting, because it is the most strongly white-marked of the six examples, and it was taken at Vunilagi, between May 25 and 31, 1921, with the powerful association of three white-marked Euploeas shown on Pls. XXXIV and XXXV. This specimen of *antilope* was the only one seen by Mr. Simmonds at Vunilagi and he "took it for a different *Euploea*." He also observed in Vanua Balavu that "it is a perfect mimic in life of the large Euploeas."

Capt. Riley kindly informs me that, of three *antilope* from Mango in the British Museum, a male and one female are slightly paler than the type from Ovalau, and a second female considerably darker. The two females were taken on the same day—July 16, 1882. These, with the type, are the only Fijian examples of *antilope* in the British Museum.

The extremely interesting capture in Rarotonga (Cook Is.) by Commander Walker of a form of *antilope* precisely resembling that from Fiji has been mentioned before and its significance considered (p. 588).

* Mr. Simmonds wrote, January 2, 1922—"I found five larvae of *Hypolimnas* and bred out four. Two of these I enclose." It may be that the second specimen was the first-mentioned male, accidentally labelled as a capture, Sept. 1, 1921. It is a nearly perfect specimen and may well have been bred.

When in Vanua Balavu Mr. Simmonds observed that *antilope* "lays a yellow egg instead of the green one of *H. bolina* [see, however, pp. 647 n., 650], and the larvae feed on a big tree." Attempts to rear them on the food-plant of *bolina* were abortive. The larvae and food-plant were, I believe, unknown until Mr. Simmonds discovered them.

There can be no doubt about the mimicry by *antilope* of the dark Euploeas in East Fiji, and Mr. Simmonds' capture at Vunilagi proves that it also exists in the western islands. It will be of the greatest interest to study a long series from this latter part of the group and ascertain how far the *Hypolimnas* has followed the white-bordered Euploeas and how far retained its mimetic likeness to the dark models of the eastern islands. We are brought back, as often before, to emphasise the importance and interest of further collections from as many islands as possible, but in this case chiefly from West Fiji.

J. CIRCUMSTANTIAL EVIDENCE OF BIRD-ATTACKS ON MEMBERS OF THE EUPLOEINE ASSOCIATION AND OTHER BUTTERFLIES IN WEST FIJI AND FOTUNA ISLAND.

(Plate XLIV, all figs.)

Many naturalists have thrown doubt on the conclusion that butterflies are much attacked by birds, while some have thought that such attacks, if made at all, are so rare that they may be neglected as a selective agency. These doubts are, I believe, chiefly felt by keen collectors of insects who, in reviewing past experiences, found that their memories were without any record bearing on a subject to which no attention had been paid. Incredulity, based on the examination of birds' stomachs in the United States, has also been expressed by American naturalists.

The large amount of evidence already in existence, but for the most part overlooked by objectors, was brought together by Dr. G. A. K. Marshall, F.R.S. (Trans. Ent. Soc., 1909, p. 329), who had himself, by well-devised experiments and observations, direct and indirect, made important contributions to the subject. (Trans. Ent. Soc., 1902, pp. 340–375.) Then followed Mr. C. F. M. Swynnerton's great paper (Linn. Soc. Journ.—Zool., xxxiii, 1919, pp. 203–385), giving an account of experiments and observations carried on in S.E. Rhodesia from 1908 to 1913, the principal

results being published in a condensed form in Proc. Ent. Soc., 1915, pp. xxxii–xliii. In these papers he showed that the negative evidence supplied by American birds was explained by a rapid digestion, which, in a short time, leaves of a butterfly nothing recognisable except with the aid of a microscope. He also directed attention, I believe for the first time, to evidence based on the V-like impression of a bird's beak on the wings of butterflies (*ibid.* p. xxxix). In the year following this communication a beautiful V-mark was observed on a female *bolina* from Madagascar —so perfect indeed that Mr. W. R. Ogilvie Grant was able to suggest the probable species of bird from the impression of its beak—*Uratelornis chimaera* Rothsch. (Proc. Ent. Soc., 1916, p. xxi).

The convincing character of this last-mentioned evidence was conclusively proved by Capt. W. A. Lamborn who, in Nyasaland, observed a wild Weaver-bird capture a Pierine butterfly and remove its wings which, when collected, exhibited marks of the beak (Proc. Ent. Soc. 1920, pp. xxiv–xxix, lvii). He also shot a wild Weaver-bird barely two hours after it had eaten two Pierines, and found no recognisable " portions of them except with the aid of the microscope " (*ibid.*, pp. xxvi, lvii).

Direct evidence of bird-attacks has also been published in Proc. Ent. Soc. by the following observers in the Ethiopian Region :—Mr. Cecil N. Barker, recording an observation by Mr. Harold Millar (1919, xxxiii), Dr. G. D. H. Carpenter (1915, lxiv; 1917, lxii), Rev. G. Cecil Day (1921, lxxiv), Capt. Lamborn (1919, xxxiv), and Mr. E. E. Platt (1915, lxxii). Also in England by the following :—Mr. H. Britten (1917, xxix), Dr. Carpenter (1920, xxxiv), Prof. E. B. Poulton (1917, xxix), and above all by Mr. W. Parkinson Curtis in his papers on " Coloration Problems " (Ent. Record, vol. xxv, 1913, and later vols.)

Further circumstantial evidence based on the V-like beak-marks has accumulated since Mr. Swynnerton and Capt. Lamborn first directed attention to it. Mr. A. H. Hamm has, during the past summer (1923), captured two specimens of *Heodes phlaeas* L., near Oxford, with beautiful beak impressions on their wings, and I was delighted to find the same marks on a *Euploea* from Fotuna I. and on two members of the West Fijian Euploeine Association, sent by Mr. H. W. Simmonds. The attacked butterflies

are represented, of the natural size, on figs. 4, 5, and 6 of Pl. XLIV. Two species of *Euploea* and the one Danaine member of the Association are represented. Mr. C. Chubb, after kindly examining a photograph of the marks, expresses the opinion that they were most probably made by Fijian birds among the following genera—*Artamus* (Wood Swallows), *Pachycephala* (Thickheads), or *Lalage* (Cuckoo Shrikes). The marks appear to indicate birds of three species, or perhaps sex may explain some of the difference.

The attack of the bird with the slenderest bill, as shown by its mark in fig. 5, was most determined, for there are other impressions crossing the sharpest on the left hind-wing and others again on the right. Although not nearly so clear as the single one, examination of the specimen itself, especially upon the under surface, indicates that there is no doubt about their nature.

It will be noticed that the mark of the bird with the broadest bill (fig. 4) was made in Fotuna I., but that all the other figures on the plate represent attacks in West Fiji. The injury to the Danaine shown in fig. 7 is nearly as convincing as the V-like marks. The hind-wings could hardly have been shorn through cleanly and symmetrically, as they came together at rest or in flight, by any enemy except a bird. The injuries inflicted on the Nymphalines represented in figs. 1–3 were more probably caused by lizards attacking when the butterflies were at rest, in accordance with the observations of Dr. V. G. L. Van Someren (Journ. E. Afr. and Uganda Nat. Hist. Soc., No. 17, Mar. 1922, p. 18 and plate; Proc. Ent. Soc. 1922, pp. xlix, xcv).

It was of great interest to find in material collected for another purpose by Mr. Simmonds, this convincing evidence of the presence in Fiji of the only selective agency which has hitherto been suggested as likely to have modified or maintained the Müllerian Associations of these islands.

APPENDIX.

On the Numerical Aspect of Reciprocal Mimicry (Diaposematic Resemblance), by Prof. H. H. Turner, M.A., D.Sc., F.R.S.

1. In considering the numerical * relations of two groups of distasteful insects it becomes necessary to make some simple assumptions, but it is curious to find (to all appearance) contradictory assumptions being made by the advocates of different theories. Thus in the brief and illuminating paragraphs in which the Müllerian view is stated (Proc. Ent. Soc. Lond., Feb. 3, 1915, p. xxiii) we read :—

"There are in a certain district two unpalatable species, the one numbering 10,000 individuals, the other 2,000. If the foes inhabiting the same district destroy annually 1,200 individuals of an unpalatable species before learning to avoid it,

(*a*) this number would be lost by each species if they were different;

(*b*) but if they were so similar that the experience with one serves for the other, then the first would lose 1,000, the other 200 individuals."

2. The division and the letters (*a*) and (*b*) have been introduced in reproduction, and do not occur in the original. They serve to compare the two extreme forms of assumption liable to be made, which are both given by Müller, who, however, proceeds to neglect (*a*) and consider chiefly (*b*). In Dr. Guy Marshall's paper, however, he insists on directing attention chiefly to (*a*): thus in Trans. Ent. Soc., 1908, p. 98, top—

* It must be borne in mind that, in the evolution of Reciprocal Mimicry, there are other important relationships in addition to the numerical. The relative variability and unpalatability of the species in a developing association must also be taken into account. But these and probably other relationships can only be dealt with one at a time, although the ultimate object must be to combine all the results in a common curve. Prof. Turner deals with the relationship considered by Fritz Müller and by Dr. Marshall. It happens, too, that in the Euploeines and the Danaine treated in this memoir—nearly related and all members of the same distasteful family or subfamily—the numerical relationship is by far the most important. It is otherwise with *H. bolina*, which is undoubtedly far less distasteful and is probably the most variable butterfly in the world.—E.B.P.

"... education of young birds ... necessitates the destruction of approximately 1,000 ***individuals in each group*** of distinctive patterns."

3. Now an outsider intervenes in such matters with obvious risks: the only contribution of value I can hope to make is by inquiring whether in this (as in other instances in my experience) a very human dislike of the complexities of mathematics has not embarrassed the argument; and whether it is not desirable to re-examine it with a little more of a mathematical procedure? I hope I shall not deter any reader at the outset. I promise to use the minimum of symbolic procedure—little more than a simple diagram; but if it happens to throw light on the essence of the matter I hope it may be excused.

4. For it does not seem to me possible to treat adequately any question of "survival of the fittest" without *some* reference, however elementary, to the "distribution curve," or the "error curve," which represents some graded feature in the horizontal direction and numbers of individuals in

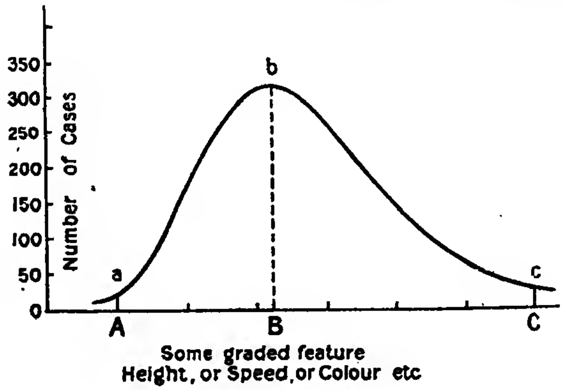


Fig. 1.

the vertical. The majority, represented by the large ordinate Bb, have the feature in a standard measure B, while A represents a measure of it in defect (say), which only a few individuals, Aa, possess, C represents an excess (say) possessed by Cc individuals.

5. The words "excess" and "defect" are too particular and suggestive; we want more colourless ones representing departures from the average in opposite directions. But no suitable ones occur to me.

6. To simplify procedure, we can retain the essential idea without using a curve (which rather suggests an elaborate formula) so long as we retain the idea of 3 groups

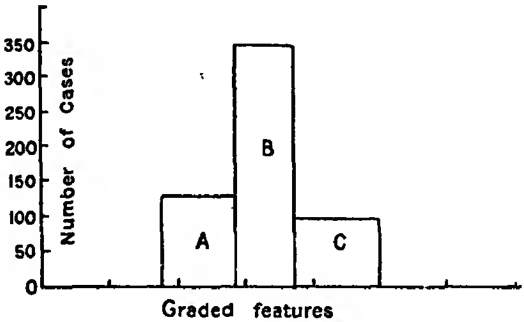


FIG. 2.

—B a large central group, A and C smaller groups (not necessarily equal to one another) deviating from B in opposite directions.

7. Now before proceeding to consider another group of individuals, let us visualise what will happen to this one under different possible conditions of "avoidance."

(*a*) The groups A and C deviate from B, on which the lessons of avoidance are chiefly learnt. The deviations may be such as to *nullify* the lesson. Thus suppose B represented a nearly circular marking ○, and A and C represented deviations from it by elongation in opposite directions.

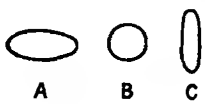


FIG. 3.

It might well happen that the lessons learnt on B were practically useless for A and C, so that destruction would proceed on A and C at a greater relative rate (almost according to alternative (*a*) in § 1): A and C would thus be gradually eliminated, and the central type B would become stable. Reversing the argument, we may infer that IF a type has become stable, the deviations from it were both *less* easily recognised than the type which has become stable.

(β) Now imagine the other extreme case, when both A and C are *more* easily recognised than B, though at the moment a good example does not occur to me. But as a bad example let us suppose for B a grey marking, which in A became whiter and in C blacker, being in both A and C more easily recognised (because more conspicuous) than in B. Then A and C would grow at the expense of B—possibly the central B would die out or die down and the series ultimately become two. [If this is a real possibility, may there perhaps be some cases of two linked patterns (where B is dying out, but not yet dead) which were originally one? This is perhaps too wild a speculation.]

(γ) But it is easier to formulate the case where, of A and C, one (say A) is less easily recognised than B and the other (C) is more easily recognised. Then A will be destroyed and C will grow, so that the central type B will move in the direction of C. This must surely be quite common in practice? In general terms we may use "excess" and "defect" here: a marking may be very *strong* or very *weak*. The weak will be destroyed and the strong avoided.

8. We may now consider two characters which are ultimately to show "mimicry." I venture to suggest that

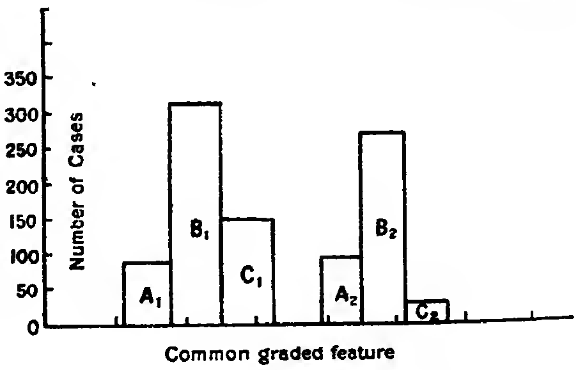


FIG. 4.

we have almost all the machinery for sound conclusions in what has been said. We require in addition only the assumption that there is *some* character which may be regarded as *qualitatively* common to the two, varying only *in degree*, so that there is a definite line of approach which we may adopt for the horizontal line in the diagram. It

may require some little consideration to specify this character in definite terms, but it must be there. Thus type (1) may be *red* in some feature, type (2) may be *yellow*; and these may seem to offer no link. But *if they come together*, there must be a link, and in this case it would be *orange*. We should therefore adopt orange as the common character, deviating on the one side into greater and greater redness, on the other side into greater and greater yellowness, as roughly indicated below.

9. Now I suggest that, if instead of inquiring whether the two series will come together, we invert the situation and say, "These two series came together; how?" then

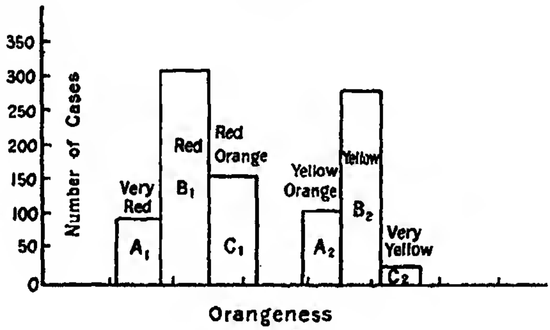


FIG. 5.

we have obtained the reply already in what precedes. No (1) series travels to the right; this must be by elimination of A_1, and growth of C_1. We conclude that *very great redness* (A_1) is less easily recognised than *redness* B_1: *i.e.* the lessons learnt from B_1 are not applied, and A_1 is gradually destroyed. Similarly with *very great yellowness* (C_2)—it is not readily recognised as being like B_2 and is attacked whenever met.

10. On the other hand C_1 and A_2 must *for some reason* be more easily recognised and therefore avoided. I underline the words *for some reason* because it seems to me that there may be more than one. The reason may be a merely numerical one, which can only happen when there is a definite overlap of C_1 and A_2. But presumably the two sets were approaching one another before this, while C_1 and A_2 were still separate; in which case the reasons for approach cannot have been founded on any *numerical* or *combined* argument, but must have been essential to

types, each separately. There must have been some reason why orange red (C_1) was more easily recognised than red (B_1) and was therefore more avoided than red: so that set (1) would move to the right—quite apart from the existence of set (2). Similarly there must have been some entomological (or "inimical") reason why A_2 should be avoided more than B_2. If we admit this, then it is natural to suppose that the same reasons would still be effective after the junction or overlap. Hence without in any way denying the effectiveness of the Müllerian (numerical) reason, which still remains to be considered, we may fairly suppose that it is reinforced by reasons which exist independently of it, and indeed existed before it could come into play.

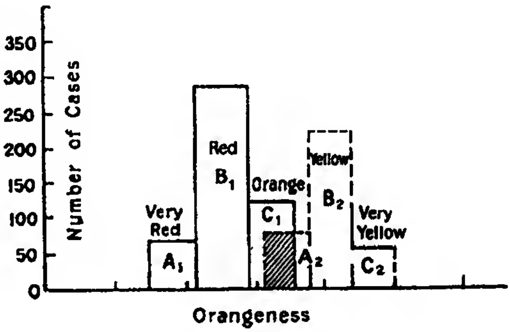


FIG. 6.

11. Reflecting on what has gone before, I venture to propound these suggestions before proceeding to the numerical relationships.

There seems to be room in the vast diversity of animal life and change for all three alternatives (α), (β) and (γ) considered in § 7.

(α) Both extreme forms may be eliminated as *less* recognisable than the average, in which case the central type is stabilised.

(β) Both extreme forms may be *more* easily recognised and therefore avoided. The extremes will grow relatively to the mean, and two types may be formed out of one.

(γ) But it must surely often be true that one extreme form is *more* easily, the other less easily recognised, in which case the mean type will "march" towards the more easily recognised extreme.

12. We now proceed to deal with the numerical interrelations of two groups. We have seen that either or both may "march" toward the other for inherent reasons, and thus we have at any rate a possible machinery for bringing them within reach of each other, so to speak; *i. e.* so that some of the extreme forms overlap. With the crude method of representation hitherto adopted, we should have to say that A_2 and C_1 overlapped; as in the shaded portion of Fig. 6.

Even with this crude representation we see that the numerical argument will depend, *not* on the relative numbers of the whole classes, or even of the majorities B_1 and B_2, but on those of the small classes C_1 and A_2, which may

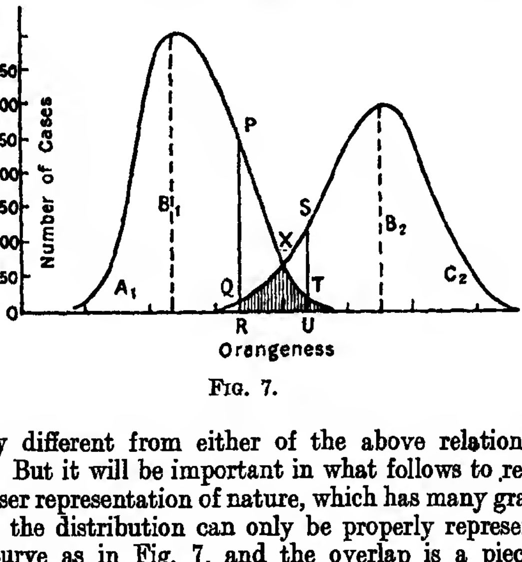


Fig. 7.

be very different from either of the above relations or ratios. But it will be important in what follows to return to a closer representation of nature, which has many grades, so that the distribution can only be properly represented by a curve as in Fig. 7, and the overlap is a piece of triangular shape.

13. Now it seems to me that this notion is very important. If we take the total numbers in the two groups, then (1) may be much more numerous than (2). The total numbers would be represented by the whole areas of the curves. But near the tip T, the members of the first group are represented by the short ordinate TU, while those of the second are represented by the much larger ordinate SU. For this particular shade of orangeness the second group is much more numerous than the first. In

fact, we easily see that in the overlapping portion of the two curves the ratio of individuals in the two sets has no relation to the ratio of the totals. Beginning with a shade near R (the tip of the second curve) set (1) is much more numerous. Proceeding to the right, set (2) grows in relative importance: at the point X (where the curves cross) it reaches equality with set (1), and after that it is in excess, the ratio becoming larger and larger as we get nearer to T, the tip of the first set.

14. Hence I propose to apply Müller's beautiful rule, *not* to the numbers in the groups as a whole, but to successive equivalent shades. Let us consider the shade near one of the tips, say T. Here set (1) is much less numerous, and will gain enormously by the protection of set (2). Of course there is only a *relative*, not an *actual* gain, indeed there is actually a *loss*, but not so great a loss for the protected portion. Diagrammatically we may represent the matter thus.

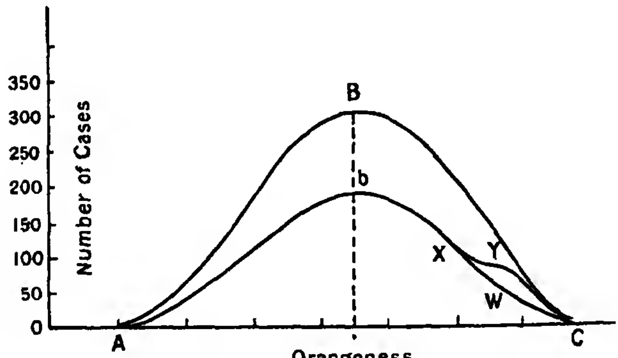


Fig. 8.

Suppose ABC the distribution curve that *would* have existed at the end of a season with no destruction, and AbWC the actual curve after destruction in which every ordinate has been reduced in about the same ratio. Then owing to the protection of set (2) the actual curve will be like AbXYC, with a slight hump near the tip. Fewer of the individuals near the tip will have been destroyed, owing to the protection of the other group.

15. I presume that, by mating, this hump XYC will presently be absorbed so as to give a smoother form to the curve; but its absorption will tend to displace the whole

curve to the right. The amount of the displacement will clearly depend on the ratio of the hump to the whole curve. If the hump is small compared with the whole curve the displacement of the group will be small—perhaps negligible.

16. Now it is easy to see how, though each of two groups must affect the other by the creation of a hump near the tip, the hump may be large for one and very small for the other, if the numbers of the whole groups are very different. Let us take two groups with the same variations (*i. e.*

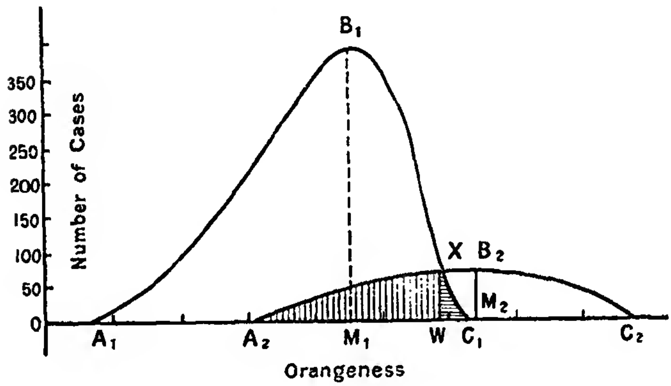


Fig. 9.

$A_1C_1 = A_2C_2$) but very different numbers (B_1M_1 much larger than B_2M_2). Then it is easily seen how much bigger the "tip" XWA_2 of the second must be than that of the first XWC_1. Both tips are protected, but the gain to the less numerous class is obviously much greater. The point is essentially Müller's point, but perhaps the diagrammatic form helps to make it clearer to the eye. In such a case as that drawn we can well imagine that the second set would grow rapidly towards the first, while the first would scarcely be affected at all. There must theoretically be some influence, but it is clearly very slight.

Explanation of Plate XXIX.

Map of the Fiji Islands.

A line drawn from Taveuni to Kandavu will separate West Fiji on the left from East Fiji on the right, the two islands being regarded as outliers of West Fiji.

Names of islands or places other than those quoted in the text are omitted from the map.

Explanation of Plate XXX.

WEST FIJI.

The four Fijian species of Euploea from the Western Islands of the group. The white pattern well developed.

The uppermost species, with sexes alike, is resembled by the species below it, this again by the two species which follow. Both likenesses are carried further in the females.

The development of the pattern in the three lower species is probably the direct and indirect effect of invasion, from the west, by the uppermost species.

Fig. 1. *Euploea helcita eschscholtzi* Feld., ♂—Ovalau: May 12, 1921. Also represented on Pl. XXXIX, fig. 2.

Fig. 2. Female of above species—N.E. coast of Vanua Levu, Vunilagi: May 25–31, 1921. Also on Pl. XXXIV, fig. 9.

Fig. 3. *Euploea boisduvalii* Luc., s.-sp. *proserpina* Butl., ♂—Ovalau: Apr. 30, 1922. Also on Pl. XXXVII, fig. 2.

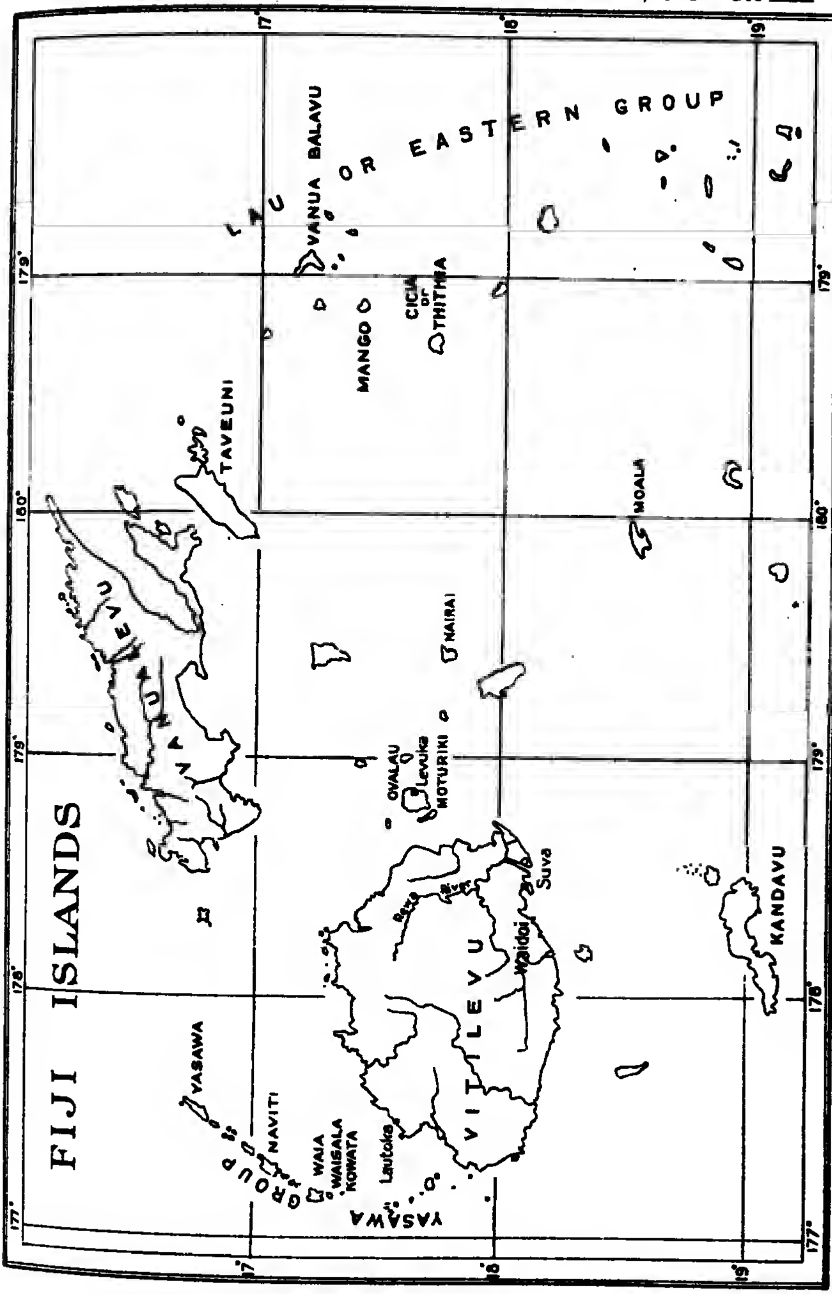
Fig. 4. Female of above species—Ovalau: Apr. 27, 1922. Also on Pl. XXXVII, fig. 5.

Fig. 5. *Euploea tulliolus forsteri* Feld., ♂. Data as in fig. 2. Also on Pl. XXXV, fig. 9.

Fig. 6. Female of above species with same data. Also on Pl. XXXV, fig. 18.

Fig. 7. *Euploea nemertes macleayi* Feld., ♂. Data as in fig. 4. Also on Pl. XXXVII, fig. 6.

Fig. 8. Female of above species. Data as in fig. 3. Also on Pl. XXXVII, fig. 12.


FIJI ISLANDS
LAU OR EASTERN GROUP
VANUA BALAVU
MANGO
CICIA or THITHIA
TAVEUNI
VANUA LEVU
NAIRAI
MOALA
OVALAU
Levuka
MOTURIKI
VITI LEVU
Suva
Waidoi
KANDAVU
YASAWA
NAVITI
WAIA
WAISALA
KOWATA
Lautoka
YASAWA GROUP

Explanation of Plate XXXI.

EAST FIJI.

The four Fijian species of Euploea from the Eastern Islands of the group. The white pattern reduced (almost wanting in fig. 4).

It is probable that the three lower species were originally even more patternless, but that they have been influenced by the uppermost species which has itself been reciprocally affected, as shown by the partial clouding over of the chief mark on the fore-wing.

The uppermost figures 1 and 2 represent another and rather larger race of the same species as that shown in the corresponding position on Pl. XXX.

Fig. 1. *Euploea helcita* Bdv., ♂, a form modified from *walkeri* H. H. Druce by reduction of hind-wing pattern and clouding over of chief fore-wing spot—Vanua Balavu: Dec. 9, 1921.

This specimen is also represented on Pl. XLI, fig. 12, together with the following, in fig. 15, and two nearly typical *walkeri* taken on the same day, in figs. 13 and 14.

Fig. 2. Female of the above form, but rather less modified from *walkeri* than that shown in fig. 1. Taken at same place and date.

Fig. 3. *Euploea boisduvalii simmondsi*, n. s.-sp., ♂. The dark E. Fijian race represented in W. Fiji by *proserpina*. The paler ground-colour of the wing-margins probably indicates affinity with *E. paykullei* of the New Hebrides—Vanua Balavu: Sept. 1, 1921. Also represented on Pl. XLI, fig. 1.

Fig. 4. Another male of the same E. Fijian form but still darker than that shown in fig. 3, and with a broader fore-wing and much larger brand. The E. Fijian female of *boisduvalii* was not received—Thithia (Cicia): Aug. 31, 1921. Also represented on Pl. XL, fig. 1.

Fig. 5. *Euploea tulliolus protoforsteri*, n. s.-sp., ♂—Mango: Dec. 8, 1921. Also represented on Pl. XXXIX, fig. 15.

Fig. 6. Female of above race taken at same place and date, and showing, like the male, a reduced fore-wing pattern. Also on Pl. XXXIX, fig. 18.

Fig. 7. *Euploea nemertes macleayi* Feld., ♂, with reduced pattern—Vanua Balavu: Dec. 9, 1921. Also on Pl. XLI, fig. 11.

Fig. 8. Female of above species with pattern reduced as compared with W. Fijian examples—Thithia: Aug. 31, 1921. Also on Pl. XL, fig. 4.

Explanation of Plate XXXII.

YASAWA IS., ·VITI LEVU.

Three of the Fijian species of Euploea (and one Danaine) from the small westernmost islands (the Yasawa Group), and two from South Viti Levu.

All Euploeas and Danaines received from the Yasawa Group are here figured.

All the Euploeas on this plate have the white or bluish pattern well developed.

Figs. 1–5. From Waisala I., S. end of Yasawa Group: Oct. 16, 1921.

Fig. 1. *Euploea helcita eschscholtzi* Feld., ♂.

Figs. 2, 3. *Euploea boisduvalii proserpina* Butl., ♂♂.

Figs. 4, 5. *Euploea tulliolus forsteri* Feld., ♀ (fig. 4); *protoforsteri* ♂ (fig. 5).

Figs. 6–10. From Naviti I., towards the centre of the Yasawa Group: Oct. 13, 1921.

Fig. 6. As fig. 1, ♂.

Fig. 7. As figs. 2, 3, ♀.

Figs. 8, 9. As fig. 4, ♀♀.

Fig. 10. *Danaida melissa neptunia* Feld., ♂. The pattern closely resembles that of Pl. XLIII, fig. 5, and is thus intermediate between the most patterned (*protoneptunia*) and the most patternless (*neptunia*) forms of this Fijian race. The specimen is No. 11 of Table A, p. 632.

Figs. 11, 12. From Yasawa I., at the N. end of group Oct. 14, 1921.

Fig. 11. As fig. 1, ♂.

Fig. 12. As fig. 5, ♂.

Fig. 13. As fig. 1, ♂. From Kowatâ I., at S. end of Yasawa Group: Oct. 11, 1921.

Figs. 14–25. From the Waidoi Valley, near Navua, S. Viti Levu, a very wet area: May and June, 1919.

Fig. 14. As fig. 1, ♀. May 27.

Fig. 15. This form of *Euploea helcita eschscholtzi*, a ♂, resembles, in the submarginal series of H.W., the race *walkeri* H. H. Druce, from Tahiti, etc. June 4. It appears to be a very rare form in the W. Fijian islands.

Figs. 16–25. As figs. 2, 3. Males in left column, females in

right: each pair taken on same day. Figs. 16, 21—May 28; figs. 17, 22—June 1; figs. 18, 23—June 2; figs. 19, 20, 24, 25—June 4.

The five pairs of this species show well the greater development of white, the more dyslegnic pattern and the paler ground-colour of the females.

Explanation of Plate XXXIII.

VITI LEVU.

Three species of Euploea and one Danaine species from S.E. and (figs. 13 *and* 14 *only) N.W. Viti Levu.*

All Euploeas show the strongly-marked W. Fiji pattern and the Danaines a transition from a patterned to patternless inner half of fore-wing.

Figs. 1 to 9—Jan. 9, 1920; figs. 10 to 12 and 15 to 18—Apr. 10, 1921. All from S.E. Viti Levu, Lower Rewa River district, Nasinu.

Figs. 13 and 14—Aug. 15, 1922. From N.W. Viti Levu (dry side of island), Vitoga River, near Lautoka.

Figs. 1 to 4 and 10. *Euploea helcita eschscholtzi* Feld., all ♂.

Figs. 5 to 9 and 11. *Euploea boisduvalii proserpina* Butl. All ♂ except fig. 9, which shows well the stronger development in the female of the chief fore-wing marking, in mimicry of *eschscholtzi.*

Figs. 12 to 14. *Euploea tulliolus forsteri* Feld., ♂♂♀. These, the only examples of this species sent by Mr. Simmonds from Viti Levu, all exhibit a well-developed fore-wing pattern.

Figs. 15–18. *Danaida melissa neptunia* Feld., all ♂. The series, all captured at the same time and place, well illustrates the gradual loss of the ancestral markings on the inner half of the fore-wing and reduction of those on inner part of the hind, in mimicry of the Euploeas.

Figs. 15 and 16 represent a transitional stage between *proto-neptunia* and *neptunia*; figs. 17 and 18 are the latter form.

Figs. 15 and 16 are both No. 6 in Table A on p. 632; fig. 17 is No. 15, and fig. 18 is No. 17 in the same table.

Explanation of Plate XXXIV.

VANUA LEVU.

Two of the Fijian Euploeas from Vunilagi on the N.E. coast of Vanua Levu. All captured May 25–31, 1921. *A third species is figured on Pl. XXXV.*

Figs. 1 to 7 males, 8 to 14 females, of *Euploea helcita eschscholtzi* Feld.

The male represented in fig. 6 is transitional towards the race *walkeri*.

Figs. 15 to 18 males, 19 to 22 females of *Euploea boisduvalii proserpina* Butl.

The females, as usual, exhibit a stronger development of the white pattern than the males. The fore-wing brand represented in fig. 15 is exceptionally small.

Explanation of Plate XXXV.

VANUA LEVU.

A third Fijian species of Euploea, making, with the two represented on Pl. XXXIV, the complete series of Euploeas captured May 25–31, 1921, *at Vunilagi, N.E. coast of Vanua Levu.*

Figs. 1 to 15 males, 16 to 21 females of *Euploea tulliolus forsteri* Feld.

The figures are arranged to show the transition from the greatest to the least development of pattern in both males and females. The greater variability of the latter sex is well shown by the fact that the males are out-distanced at both ends of the series, fig. 21 representing the weakest, and fig. 16 the strongest pattern on the plate. The average development of the female pattern is, of course, much higher than that of the males.

Figs. 14, 15, and 21 are the form *protoforsteri*.

Explanation of Plate XXXVI.

MOTURIKI, TAVEUNI.

Two of the Fijian species of Euploea from Moturiki, a small island E. of Viti Levu, and near the S.W. corner of Ovalau; and three species from Taveuni, S.E. of Vanua Levu.

Figs. 1 and 2. Moturiki: Aug. 11, 1920. The only Euploeas received.

Fig. 1. *E. helcita eschscholtzi* Feld., ♀.

Fig. 2. *E. boisduvalii proserpina* Butl., ♀.

Figs. 3 to 12. Taveuni: dates as given. In addition to the specimens figured three more male *proserpina* (taken December 19, 1921, and March 9 and 18, 1922), with patterns transitional between those shown in figs. 5 and 6, were received. Fig. 7 shows an extremely interesting male *proserpina* transitional towards the E. Fijian forms with still more reduced pattern. Nothing like this

specimen was seen in the large numbers received or studied from islands W. of Taveuni except a single male from the outlying southern island Kandavu (Pl. XXXIX, fig. 5).

Fig. 3. *E. helcita eschscholtzi*, ♂: Dec. 11, 1921.
Fig. 4. „ „ , ♀: Dec. 17, 1921.
Fig. 5. *E. boisduvalii proserpina*, ♂, : Dec. 21, 1921.
Fig. 6. „ „ , ♂, : Dec. 19, 1921.
Fig. 7. „ „ , ♂: Mar. 18, 1922.
Fig. 8. „ „ , ♀: Dec. 11, 1921.
Fig. 9. „ „ , ♀: Dec. 18, 1921.
Fig. 10. *E. tulliolus forsteri* Feld, ♂: Mar. 18, 1922.
Fig. 11. „ „ , ♂: Dec. 18, 1921.
Fig. 12. „ „ , ♀: Dec. 11, 1921.

All these three are near the border line between *forsteri* and *protoforsteri*.

Explanation of Plate XXXVII.

OVALAU.

The four Fijian Euploeas from Ovalau, the island in which the white pattern reaches its highest development. The figured specimens, together with the far greater numbers received from Ovalau, are tabulated on p. 617.

Fig. 1. *E. helcita eschscholtzi*, ♀: Apr. 27, 1922. The figured example was the only Ovalau specimen with the H.W. of *walkeri*; the others, tabulated on p. 617, are all typical *eschscholtzi*.

Figs. 2 to 4. *E. boisduvalii proserpina*, ♂♂♀: Apr. 30, 1922.
Fig. 5. „ „ , ♀: Apr. 27, 1922.
Figs. 6 and 9. *E. nemertes macleayi* Feld., ♂♀: Apr. 27, 1922.
Figs. 7 and 10. „ „ , ♂♀: Apr. 28, 1922.
Figs. 11 and 13. „ „ , ♀: Apr. 29, 1922.
Figs. 8 and 12. „ „ , ♀: Apr. 30, 1922.
Figs. 14 and 15. *E. tulliolus forsteri*, ♂: Oct. 22, 1921.
Fig. 16. „ „ , ♂: May 3, 1922.
Fig. 17. „ „ , ♂: May 9, 1922.

Explanation of Plate XXXVIII.

(Natural size.)

OVALAU.

Members of mimetic association captured within two minutes of one another on a hill, Levuka, Ovalau: Sept. 9, 1920. *A second bred example of one member.*

Fig. 1. *E. helcita eschscholtzi*, ♀.

Fig. 2. *E. boisduvalii proserpina*, ♂.

Fig. 3. *Hypolimnas bolina* L., ♀ form which, on the wing, resembles the above Euploeas.

Fig. 4. *H. bolina*, ♀ form similar to fig. 3, but with stronger external and weaker internal pattern: probably as good a mimic as fig. 3, or even better. Bred Nov. 2, 1920, from larva found at Levuka. This form resembles *murrayi* Butl.

Explanation of Plate XXXIX.

OVALAU, KANDAVU, MANGO.

Fijian Euploeas of western, mixed and eastern patterns from Ovalau, Kandavu, and Mango, respectively.

Ovalau: May 12, 1921. Compare Pls. XXXVII and XXXVIII.

Figs. 1 to 3. *E. helcita eschscholtzi*, ♂.

The specimen represented in fig. 3 has the chief marking of the fore-wing clouded over—the only example of this kind received from West Fiji and perhaps due to interbreeding with a more eastern form. It will be observed that the specimen closely resembles the forms of *helcita* from Wallis I. (Pl. XLII, figs. 8–12).

Kandavu: July 24, 1921. The mixed and intermediate patterns, the latter very obvious in the form of *boisduvalii* (fig. 5), are consistent with the supposition that the invading *helcita* (fig. 4) reached this rather remote southern island much later than the other less isolated western islands.

All the Euploeas received from Kandavu are figured on this plate, and all were captured on the same day.

Fig. 4. *E. helcita eschscholtzi*, ♂. Typical pattern: specimen large like *walkeri* (fig. 10).

Fig. 5. *E. boisduvalii*, ♂, intermediate between *proserpina* and the eastern patternless or nearly patternless race *simmondsi*, and rather nearer the latter than the Taveuni specimen (Pl. XXXVI, fig. 7).

Figs. 6–8. *E. nemertes macleayi*, ♂♀♀. Compared with the Ovalau series on Pl. XXXVII (figs. 6–13), it is seen that two out of the three Kandavu specimens are less patterned, especially in the hind-wing markings.

Fig. 9. *E. tulliolus forsteri*, ♂. This specimen is western in pattern and shows no approach towards the darker forms from Mango represented on the same plate (figs. 12–18).

Mango: all Dec. 8, 1921, except fig. 11—July 18, 1882.

E. helcita is represented by a single example of the race *walkeri*, unchanged by the presence of two dark Euploeas which are themselves nearly or perhaps completely unaffected. It appears probable that *walkeri* is a comparatively recent arrival in the island, although some specimens in other collections have the chief mark of the fore-wing more or less clouded over (pp. 626, 627).

It is unfortunate that *E. boisduvalii* was not taken with the other Euploeas.

Fig. 10. *E. helcita walkeri*, ♀.

Fig. 11. *E. nemertes macleayi*, ♀, a British Museum specimen captured by C. M. Woodford. It is slightly darker than the two females received from Thithia (Pl. XL, figs. 3, 4).

Figs. 12 to 18. *E. tulliolus protoforsteri*, 5 ♂ 2 ♀—a very dark series, as will be realised when compared with Pl. XXXV. The British Museum series from Mango, of about equal length, resembles this, so that the comparison rests upon a fair amount of material. Fig. 12 represents the darkest example of this species received from Mr. Simmonds, although one from Vanua Balavu closely approaches it (Pl. XLI, fig. 5).

Explanation of Plate XL.

THITHIA (CICIA).

The four Fijian Euploeas from Thithia (Cicia), with eastern, intermediate, and western patterns.

The plate shows all the Euploeas received from this island—figs. 1–13 captured Aug. 31, 1921; figs. 14, 15 captured Dec. 8, 1921.

Figs. 1, 2. *E. boisduvalii simmondsi*, ♂. The specimen represented in fig. 1 is, next to that on Pl. XLI, fig. 3, the darkest and most patternless example of this species received from Fiji. Fig. 2, on the other hand, represents a specimen well advanced towards *proserpina*, and very similar to some of the males from the western islands, *e. g.*, to those shown on Pl. XXXIII, figs. 5, 6, from Viti Levu.

Figs. 3, 4. *E. nemertes macleayi*, ♀, both somewhat dark eastern forms, although less dark than the single specimens from Mango and Vanua Balavu. The stronger western patterns are evident in the six Ovalau females (Pl. XXXVII, figs. 8–13).

Figs. 5–8 and 14. *E. tulliolus forsteri*, all ♂ except figs. 7, 8. These specimens are, except that shown in fig. 8, near the border-line between *forsteri* and *protoforsteri*. Fig. 8 is a strongly marked

western form of the female. This species is much darker in Vanua Balavu and still more so in Mango.

Figs. 9–13, and 15. *E. helcita walkeri*, typically E. Fijian except fig. 11, in which H.W. is transitional towards *eschscholtzi*, all ♂ except fig. 13. The principal fore-wing marking is partially obscured in fig. 9, slightly in 10, while the dyslegnic edge more or less evident in the same part of the border of the remaining specimens probably indicates the origin and direction of the cloudy growth.

Explanation of Plate XLI.

VANUA BALAVU (BAVATU).

The four Fijian Euploeas, on the whole of the darkest type, from the most eastern island visited—Vanua Balavu.

All Euploeas received from the island are represented on the plate—figs. 1, 2, 4–7 captured Sept. 1, 1921; figs. 3, 8–15 captured Dec. 9, 1921.

The darkness of the three indigenous Euploeas and the effect produced on the invading *helcita* are very evident.

Figs. 1–3. *E. boisduvalii simmondsi*, ♂. All of the dark eastern type and fig. 3 the most patternless Fijian specimen received. The paler borders evident in figs. 1 and 3 are also seen in the same form from Wallis I. (Pl. XLII, figs. 1–7), and suggest that these and *E. paykullei* Butl., from the New Hebrides, are closely related forms of the same species.

Figs. 4–10. *E. tulliolus protoforsteri*, all ♂ except fig. 10. The patterns are, on the whole, more reduced than in any island except Mango (Pl. XXXIX).

Fig. 11. *E. nemertes macleayi*, ♂. In spite of its poor condition it is obvious that this is the darkest example received from Fiji. The traces of a pattern on the right hind-wing are much fainter, and the fore-wing markings more reduced than in any other specimen.

Figs. 12–15. *E. helcita walkeri*, ♂, except fig. 15. The pattern of H.W. of fig. 15 is transitional towards *eschscholtzi*, and that of fig. 12 still more so. All four specimens show a reduction or clouding over of the chief mark of F.W. This, which is especially evident in figs. 12 and 13, is shown, by comparison with Plate XLII, to be due to the influence of the dark-winged Euploeas, nearly all of which show the effects of reciprocal mimicry in the more or less distinct traces of a marginal pattern.

Explanation of Plate XLII.

WALLIS AND FOTUNA IS., BETWEEN FIJI AND SAMOA.

Euploea helcita walkeri captured in Wallis I. with, in Fotuna I. without, the dark Euploea—E. boisduvalii simmondsi. Indications of Reciprocal Mimicry in Wallis I.

All the Euploeas received are figured, *E. helcita* being of the strongly-patterned form *walkeri* on Fotuna I., 178 miles from the N.E. tip of Vanua Levu and 296 from the centre of the Fiji Group, but with greatly reduced pattern where it is accompanied by a dark *Euploea*, on Wallis I., 322 and 430 miles from the same points, and 150 miles from Fotuna I.

Fotuna I.: May 25–26, 1922 (figs. 13–19).

Wallis I.: May 30, 1922 (figs. 1–12).

Figs. 1–7. *Euploea boisduvalii simmondsi*, all ♀ except figs. 1, 2. The extremely close resemblance to the Vanua Balavu form is obvious. Compare especially fig. 2 on this plate with fig. 1 on Pl. XLI.

The pale margins of both these males appear to have been derived from *paykullei* of the New Hebrides. One male (fig. 2) and two females (figs. 6, 7) appear to show reciprocal approach towards the reduced pattern of the race of *helcita* on the same island (figs. 8–12).

Figs. 8–12. *Euploea helcita* with reduced pattern, all ♀ except fig. 10. These specimens, taken with the above dark *Euploea*, are similar to a form from the Ellice Is., named *distincta* Butl. in the British Museum.

Figs. 13–19. *Euploea helcita walkeri*, ♂♂—13 to 15, 19; ♀♀—16 to 18. This form is well-known from the Society Is. and is also shown by Mr. Simmonds' captures to be characteristic of E. Fiji.

The comparison between this series of *helcita* and that from Wallis I., only 150 miles distant, is very striking.

The distinct impression of a bird's beak will be seen near the apex of the right fore-wing in fig. 19. The same specimen is shown of the natural size on Pl. XLIV, fig. 4.

Explanation of Plate XLIII.

The gradual reduction of the internal pattern of a Fijian Danaine butterfly, in mimicry of the white-bordered Euploeas.

Figs. 1–3 show the ancestral pattern, essentially similar to that found in allied races over a wide range. This is the form *protoneptunia.*

Figs. 4–6 show the loss of the principal marking in the cell of the fore-wing and the increasing reduction of the three more basal markings. Transitional forms.

Figs. 7–9 show the still further reduction and final disappearance of these three markings and the great reduction in the internal pattern of the hind-wings. This is *neptunia* Feld.

All the figured specimens are ♂ except 9.

Fig. 1. *Danaida melissa neptunia*, n. f. *protoneptunia*.—Taveuni: Dec. 20, 1921. The ♂ Type of *protoneptunia*.

Fig. 2. The same—Taveuni, Ura: Mar. 18, 1922.

Fig. 3. „ Ovalau: Apr. 27, 1922.

Fig. 4. Transitional between *protoneptunia* and *neptunia*—Ovalau: May 12, 1921.

Fig. 5. The same—Ovalau: Apr. 27, 1922.

Fig. 6. „ „ May 3, 1922.

Fig. 7. *D. m. neptunia*—S.E. Viti Levu, Lower Rewa Riv. district, Nasinu: Apr. 29, 1921.

Fig. 8. The same—Ovalau: May 18, 1922.

Fig. 9. „ S.E. Viti Levu, 5 miles from Suva on Waidoi rd., Lami: Aug. 28, 1920.

Explanation of Plate XLIV.

(Natural size.)

Injuries inflicted by birds, or in some instances probably by lizards, on Fijian butterflies and one from Fotuna I.

Figs. 1, 2. *Issoria egista* Cram., ♂—N.E. coast Vanua Levu, Vunilagi: May 25–31, 1921, and Mar. 8, 1922.

Fig. 3. *Doleschallia bisaltide* Cram., f. *vomana* Fruhst., ♂—Ovalau: Oct. 27, 1921.

These injuries to both hind-wings were evidently inflicted when they were closed—possibly during flight, but almost certainly when the insects were at rest. They are probably due to the attacks of lizards.

Fig. 4. *Euploea helcita walkeri*, ♂—Fotuna I.: May 26, 1922. The mark of a bird's beak near the apex of the right fore-wing is remarkably distinct.

Fig. 5. *Euploea boisduvalii proserpina*. ♂—S. Viti Levu, near Navua, Waidoi: Apr. 22, 1919. The impression of a narrower beak is equally clear on the left hind-wing. Other less clear impressions can also be made out on both hind-wings.

Fig. 6. *Danaida melissa neptunia*, ♂—S.E. Viti Levu, near Suva, Lami: Aug. 28, 1920. The beak-mark on the right fore-wing is

equally distinct. The male scent-pockets on the hind-wings of this specimen have been attacked, probably by house-ants. The injuries can be partially seen by comparing this figure with 7, and with 1–8 on Pl. XLIII. The specimen represented in fig. 6 is No. 21 of Table A (p. 632).

Fig. 7. As above, ♂—S. Viti Levu, Waidoi: June 6, 1919. The cleanly shorn hind-wings suggest the attack by a bird upon the butterfly in the position of rest. The specimen represented in fig. 7 is No. 9 of Table A (p. 632).

Explanation of Plate XLV.

Fijian *Hypolimnas bolina* (nearly ⅘ natural size.)

Male, two forms of female, pupa, larva, and food-plant, from a coloured drawing by G. F. Mathew.

Figs. 1, 1A.—Upper and under surface of the male.

Figs. 2, 2A.—Upper and under surface of a female form with a somewhat reduced *nerina* pattern. Typical *nerina* is the prevalent form in the S. and E. Malay Archipelago, Australia, and the West Pacific islands. It occurs reduced, and also transitional towards other forms over the whole of Polynesia. Compare the more reduced patterns (*elliciana*) represented in Pl. LIII, fig. 3.

Figs. 3, 3A.—The female form *euploeoides,* mimicking a dark and nearly patternless *Euploea.* Its existence in West Fiji, where the Müllerian Association is conspicuously white-bordered, is evidence that this part of the group was inhabited in the recent past by dark Euploeas such as still persist in East Fiji.

The larva resembles the form in Aitutaki, Cook Islands. In the Marquesas and Societies it is much darker.

The different tints of the pupa may have been caused by response to lighter and darker surroundings. Allied species are known to possess this power.

The food-plant *Sida fallax* (Malvaceae). The drawing of the flower may have been made from a variety instead of the usual five-petalled form, or the number of petals may have been due to inadvertence.

Explanation of Plate XLVI.

Fijian *Hypolimnas bolina* (natural size).

Fam. 1.—*Female Forms in small All-female Family of Female Parent Z, from Suva.*

The much-worn Female Parent Z, taken July, 1921, resembles fig. 3.

FORMS OF FEMALE OFFSPRING PRESENT IN FAMILY.

Fig. 1. This female and that represented in fig. 3 are the dark mimetic form *euploeoides* with the addition of elements from other patterns.

Fig. 2. This mixture of the mimetic with other elements in a reduced condition approaches the form *murrayi*.

Fig. 3. Another combination of the mimetic form with other elements, including a trace of the "*nerina* red" on F.W.

Fig. 4. A male-like female of the form *naresi*, but with larger white patches and a trace of the "*nerina* red" on F.W.

The family included a fifth female which resembled fig. 3, and the female parent.

EXPLANATION OF PLATE XLVII.

Fijian *Hypolimnas bolina* (natural size).

FAM. 2.—*Female Forms in All-female Family of Female Parent Y, from Suva.*

The much-worn female parent, taken July 9, 1921, resembles fig. 1.

FORMS OF FEMALE OFFSPRING PRESENT IN FAMILY.

Fig. 1. Six females of this form, two of them with no orange in H.W. centre and only a trace of blue. Fig. 1 approaches *montrouzieri*, the differences being apparent when fig. 2 is compared.

Fig. 2. Two females of this form, which only differs from the type of *montrouzieri* in the less development of orange, especially at F.W. apex.

Fig. 3. Three females of this form, one of them with less blue in H.W. centre.

Two other females differ from fig. 3 in the clouding over of the F.W. chief mark with scattered scales, thus approaching the form *murrayi*.

Fig. 4. Two females of this form—*euploeoides*, with the addition of traces of chief mark in F. and H.W.

One additional female retained by Mr. Simmonds resembled fig. 1 or 2; 1—fig. 2 or 3; 1—fig. 4, or came between 3 and 4.

This family was somewhat larger than the numbers indicate, as the last few to emerge were retained, as also in families 6 and 7.

Explanation of Plate XLVIII.

Fijian *Hypolimnas bolina* (natural size).

Fam. 3. *Female Forms in Bisexual Family* (*including one Male, received*), *with their Female Parent, K, from Ovalau.*

Fig. 1. Female parent K, taken May 6, 1922. It is seen to be of a form intermediate between the offspring represented in figs. 2 and 3, but probably nearer to the latter.

Forms of Female Offspring present in Family.

Fig. 2. Two females of this form.
Fig. 3. The only example of this form.
Fig. 4. Four females of this form.

The family contained 4 additional females—3 like fig. 2 or 3; 1 like fig. 4. One male was received.

Explanation of Plate XLIX.

Fijian *Hypolimnas bolina* (3/4 natural size).

Fam. 4.—*Female Forms in All-female Family of Female Parent O, from North Vanua Levu.*

The much-damaged female parent, taken Sept. 18, 1922, evidently resembled fig. 1.

Forms of Female Offspring present in Family.

Fig. 1. Four females of this form.
Fig. 2. Three females of this form.
Fig. 3. One female of this form.
Fig. 4. Two females of this form.
Fig. 5. Three females of this form, and two with the H.W. chief mark larger and with more extensive white.
Fig. 6. Five females of this form.

It is interesting to note the stability of this combination of the *euploeoides* form with an evanescent chief mark in F.W. All 5 females were similar in this respect.

Of 6 females retained by Mr. Simmonds, 2 resembled fig. 1; 2—fig. 3 or 4; 2—fig. 5 or 6. The 2 like fig. 1 have been added to the above 4 in the legend of Pl. XLIX.

Explanation of Plate L.

Fijian *Hypolimnas bolina* (natural size).

Fam. 5.—*Female Forms in Bisexual Family* (*including* 9 *Males*), *with their Female Parent S, from Taveuni.*

Fig. 1. Female parent S (*pallescens*), taken Sept. 4, 1921.

Forms of Female Offspring present in Family.

Fig. 2. Five females of this form (*pallescens*), 2 of them with smaller chief marks on F. and H.W. One of these latter is a bred specimen which probably, but not certainly, belongs to this family (see p. 659).

Fig. 3. Five females of this form, 2 of them with rather darker orange ground-colour and 1 with basal dark areas emphasised in depth and extent, and a trace of blue and white chief mark on H.W.

Fig. 4. Three females of this form, 1 of them with a very faint trace of blue and white H.W. mark, and 1 intermediate between figs. 2 and 4, and with an emphasised F.W. oblique bar.

Explanation of Plate LI.

Fijian *Hypolimnas bolina* (natural size).

Fam. 6.—*Female Forms* (*continued on Pl. LII*), *in Bisexual Family* (*including* 13. *Males*), *with their Female Parent X from Kandavu.*

Fig. 1. Female parent X, taken July 25, 1921. Allowing for its worn and faded condition it is seen to be of the form represented in fig. 2.

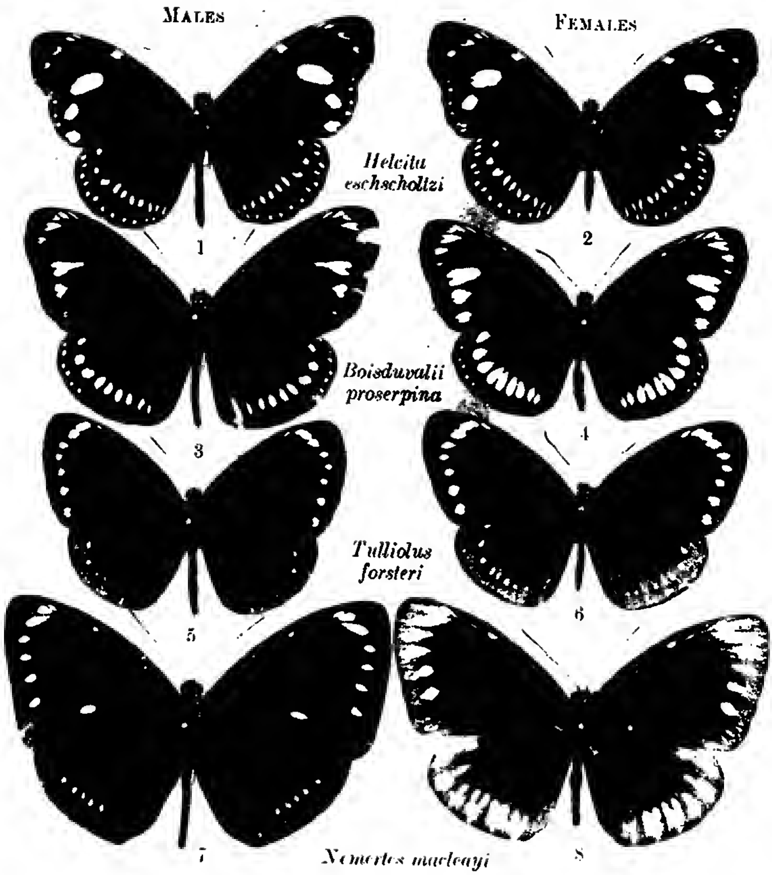
Forms of Female Offspring present in Family.

Fig. 2. Two females of this form.

Fig. 3. Two females of this form.

Fig. 4. Two females of this form, one of them with reduced orange markings in F.W., but emphasised in H.W., and without the blue and white mark in H.W.

(Family continued on Pl. LII.)

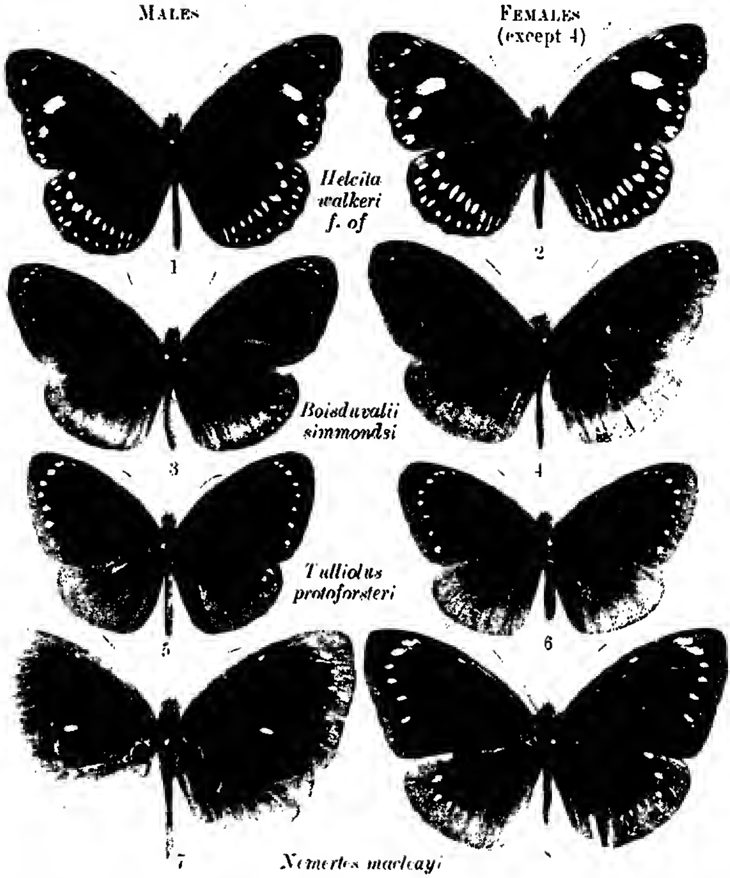


A. Robinson, Photo.

Vaus & Crampton.

All the figures are rather over ½ nat. size.

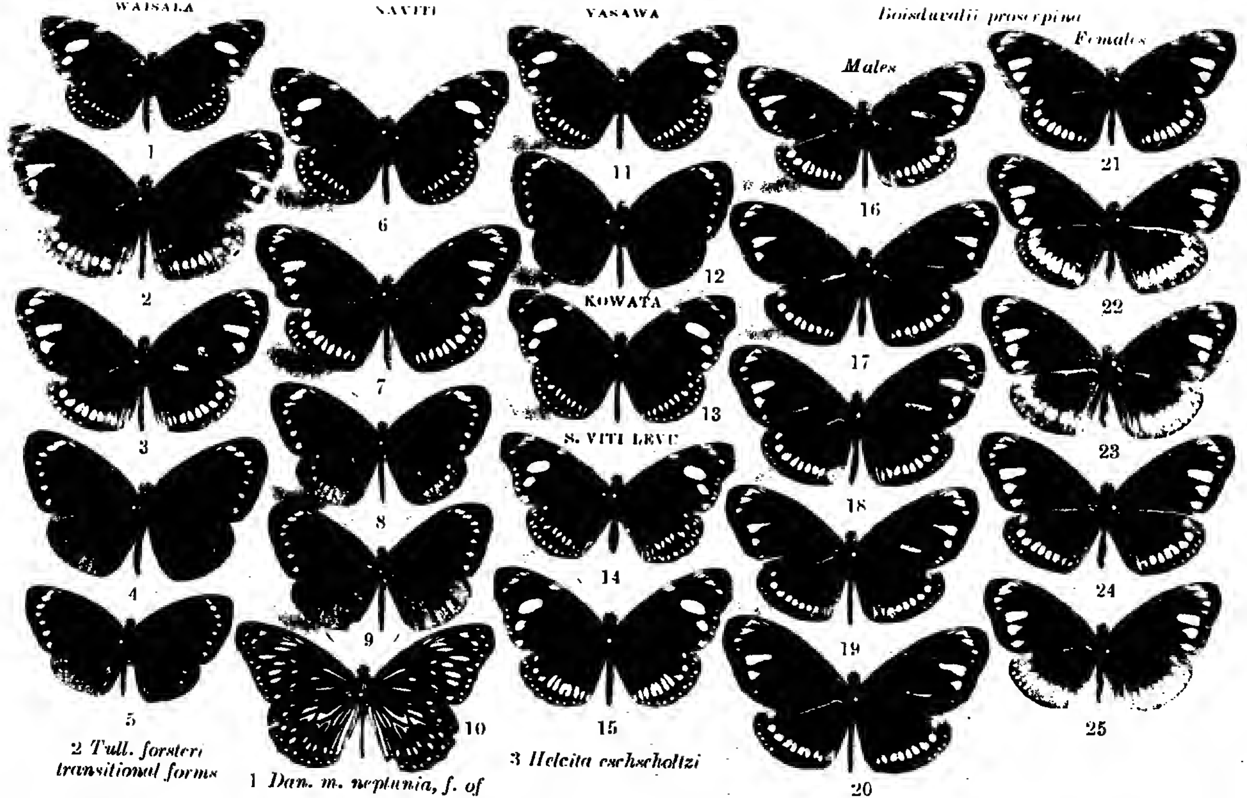
THE FOUR FIJIAN SPECIES OF EUPLOEA FROM THE WESTERN ISLANDS OF THE GROUP. THE WHITE PATTERN WELL DEVELOPED.



A. Robinson, Photo. *Vaus & Crampton.*

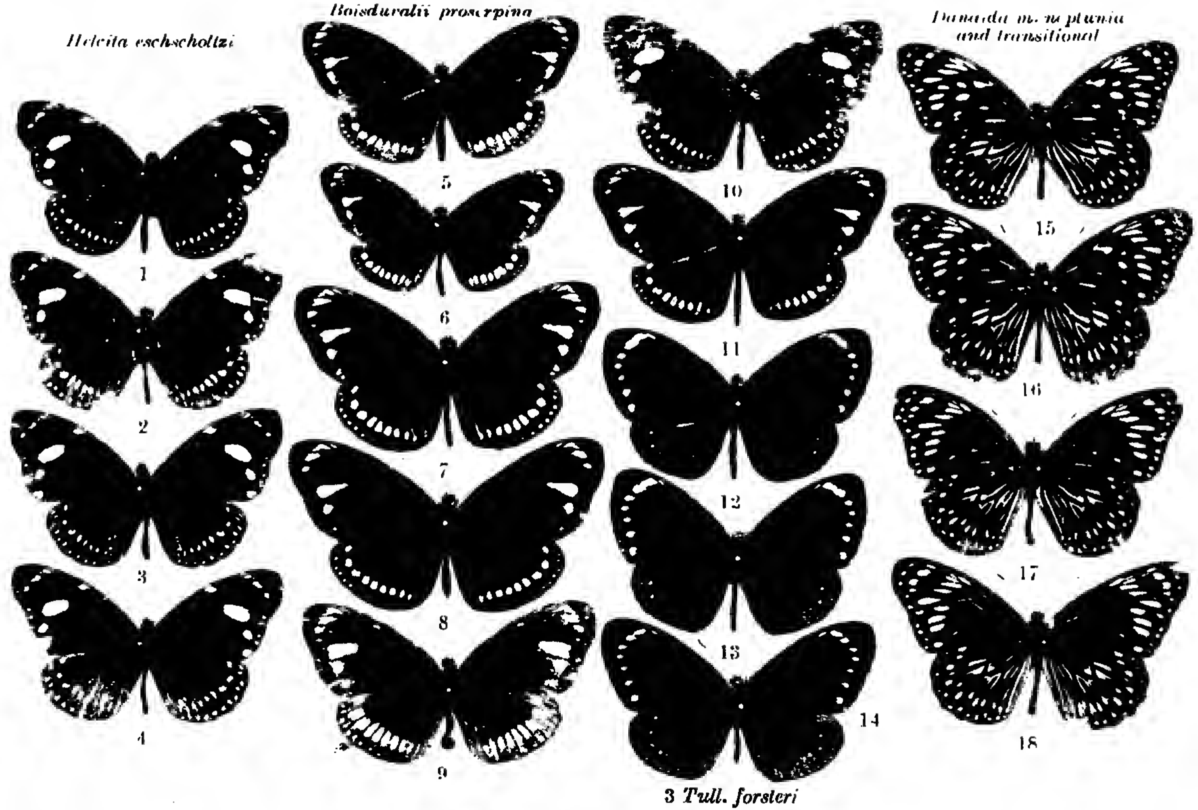
All the figures are rather over ½ nat. size.

THE FOUR FIJIAN SPECIES OF EUPLOEA FROM THE EASTERN ISLANDS OF THE GROUP. THE WHITE PATTERN REDUCED.



A. Robinson, Photo.

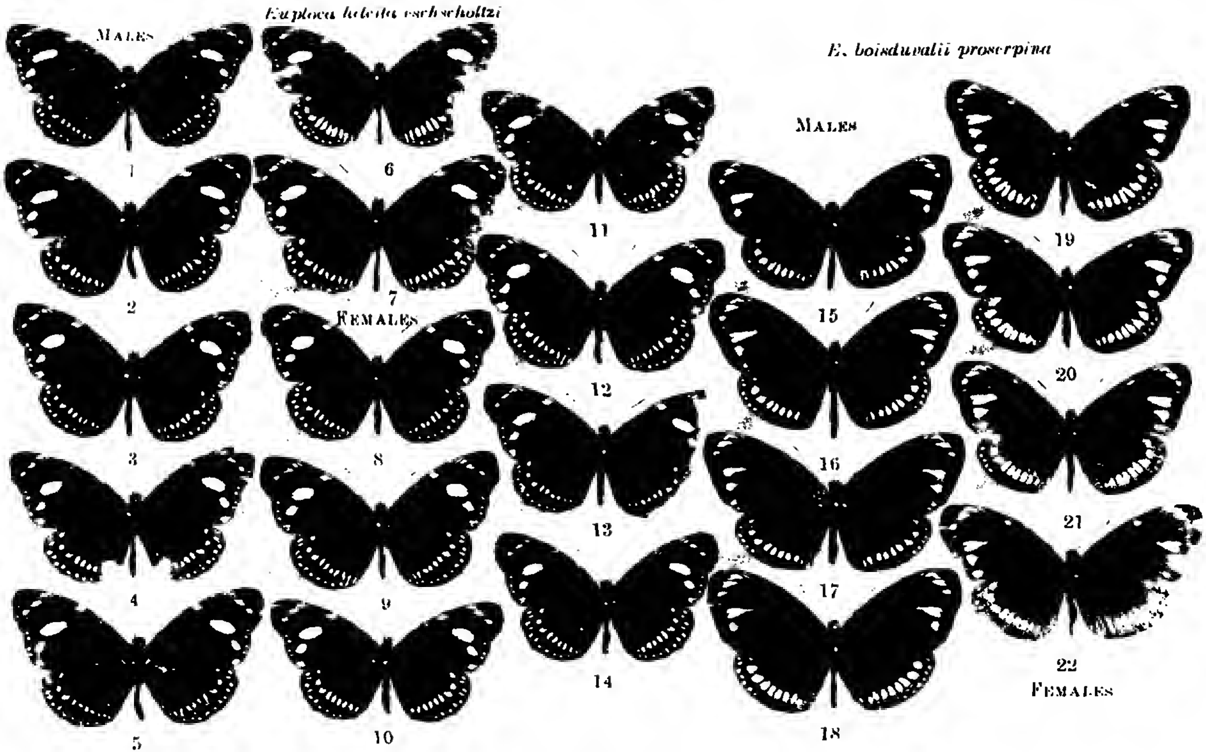
All the figures are rather near



A. Robinson, Photo.

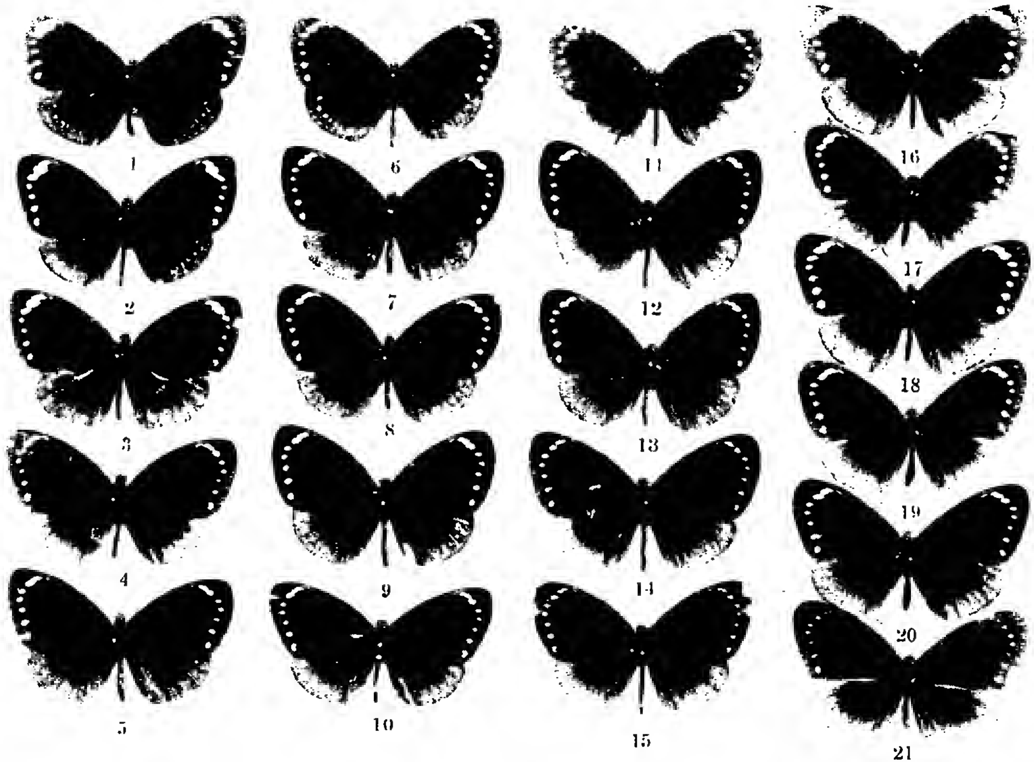
All the figures are rather over ½ nat. size.

Vaus & Crampton



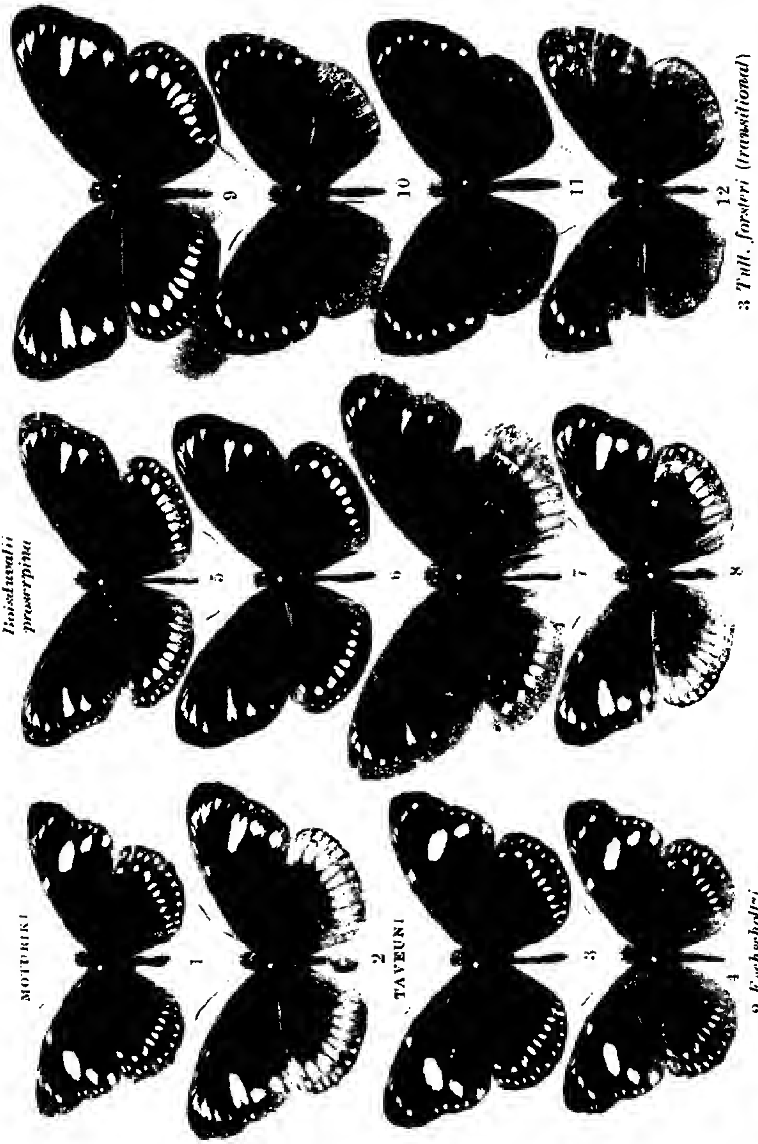
A. Robinson, Photo.

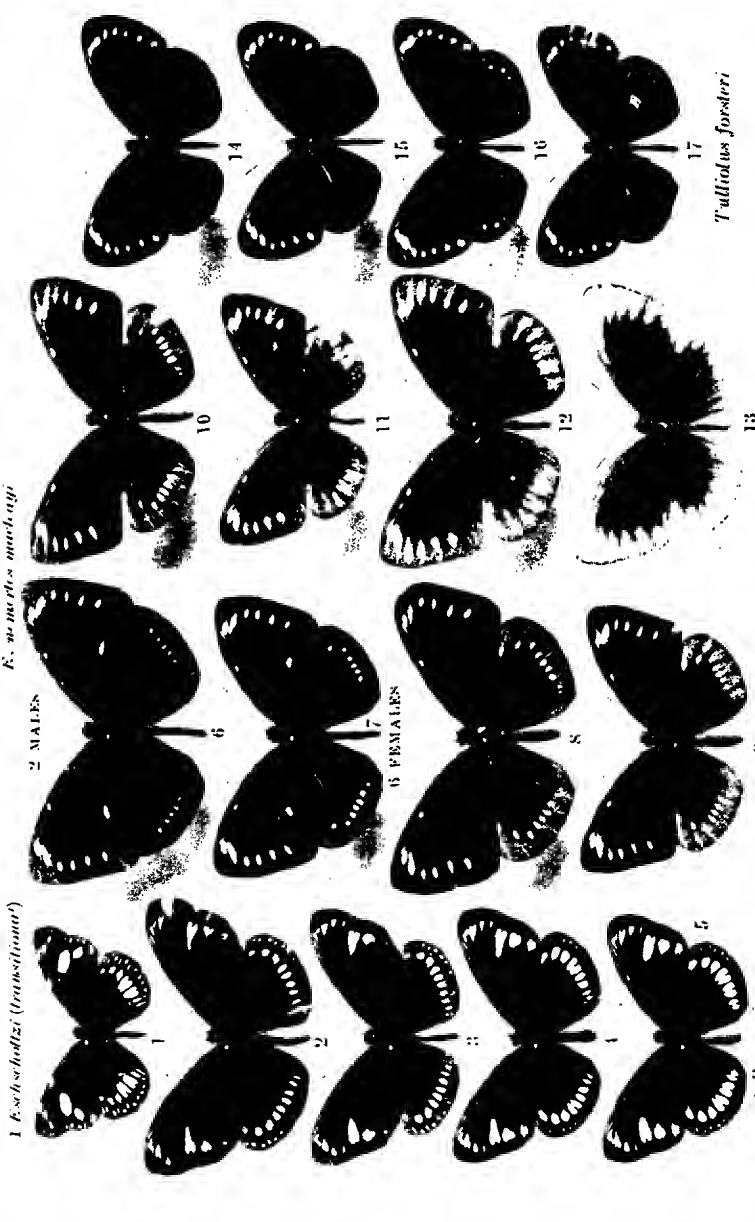
All the figures are rather under ½ nat. size.



A. Robinson, Photo. *All the figures are rather under ½ nat. size.* *Vaus & Crampton.*

EUPLOEA TULLIOLUS FORSTERI FROM N.E. VANUA LEVU

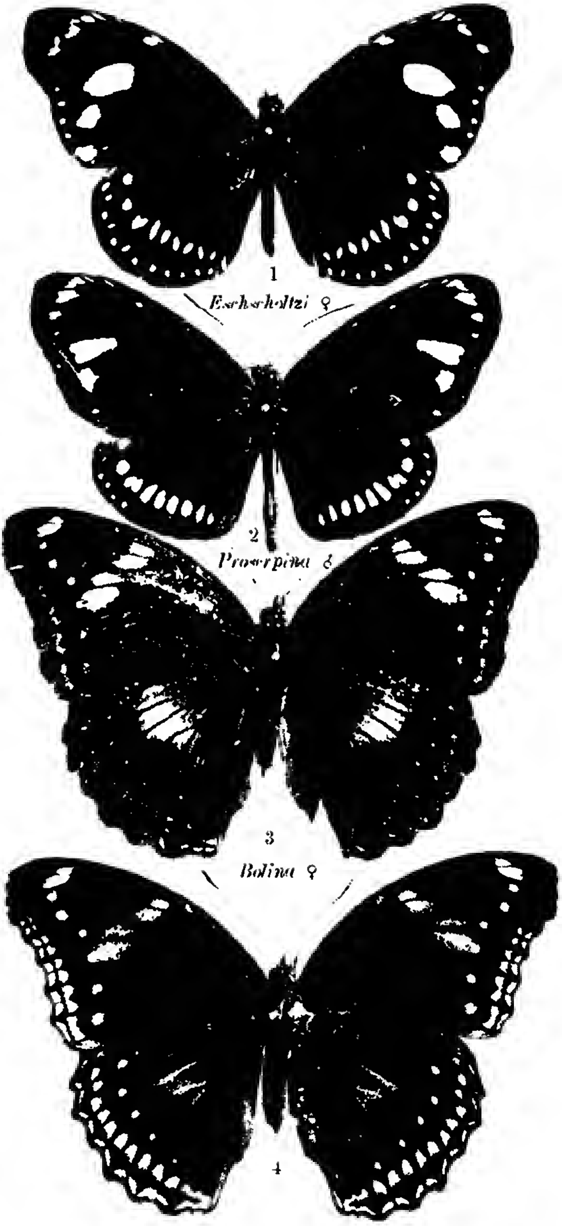

MOTURIKI
TAVEUNI
2 Eschscholtzi
Boisduvalii
proserpina
3 Tull. forsteri (transitional)
1
2
3
4
5
6
7
8
9
10
11
12



All the figures are ½ nat. size.

A. Robinson, Photo.

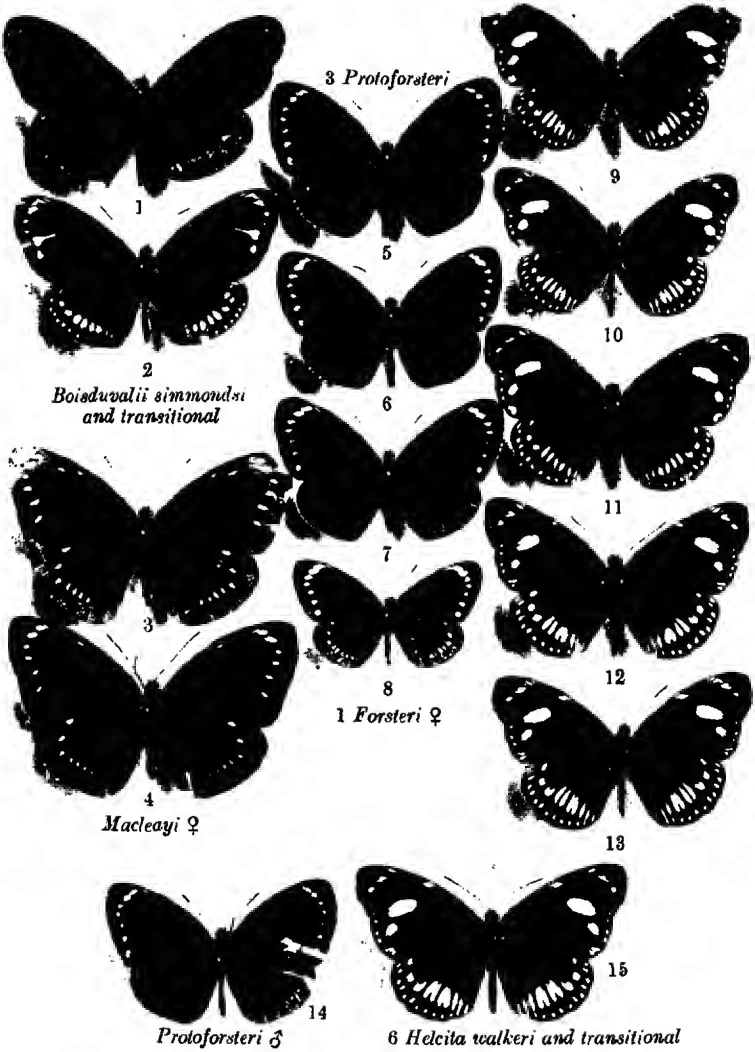
Vane & Cranston



A. Robinson, Photo. *Vaus & Crampton.*

Figures are nat. size.

MIMETIC ASSOCIATION (Figs. 1–3) TAKEN WITHIN TWO MINUTES: OVALAU. BRED ♀ H. BOLINA (4) FROM SAME ISLAND.



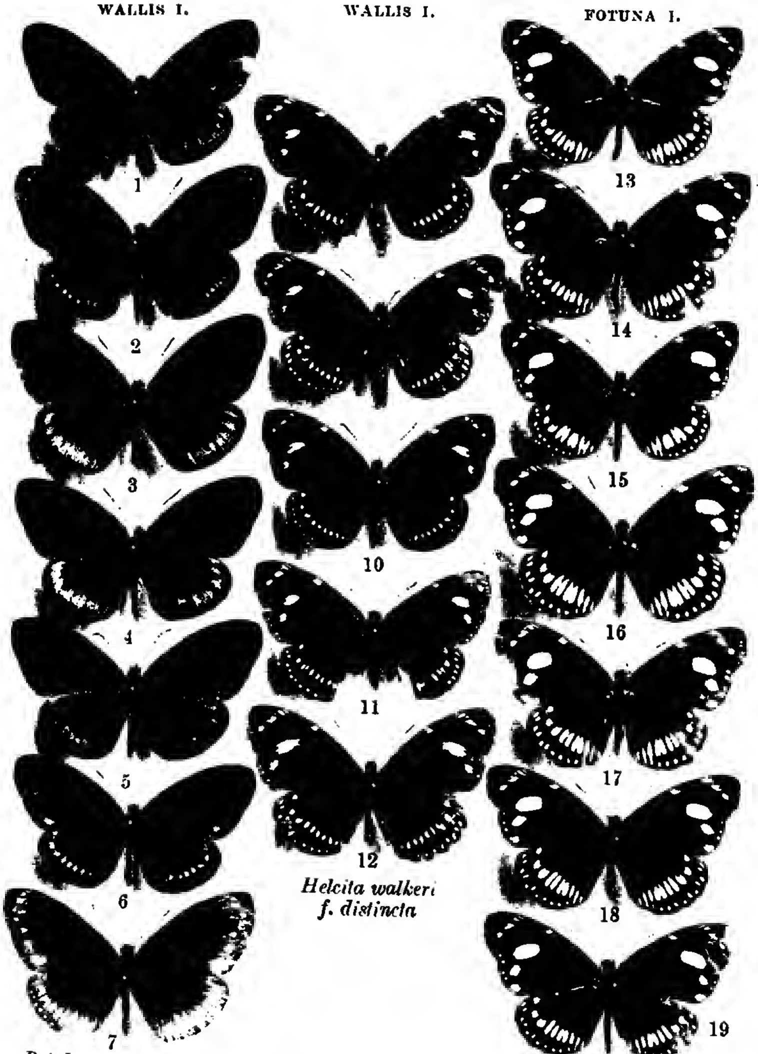
A. Robinson, Photo. *Vaus & Crampton*

All the figures are rather under ½ nat. size.

THE FOUR FIJIAN EUPLOEAS FROM THITHIA (CICIA); WITH EASTERN, INTERMEDIATE AND WESTERN PATTERNS.


12
13
14
15
Helcita walkeri and transitional
11
Macleayi ♂
8
9
10
5
6
7
Euploea tulliolus protoforsteri
1
2
3
4
Boisduvalii simmondsi ♂

WALLIS I. WALLIS I. FOTUNA I.



Boisduvalii simmondsi

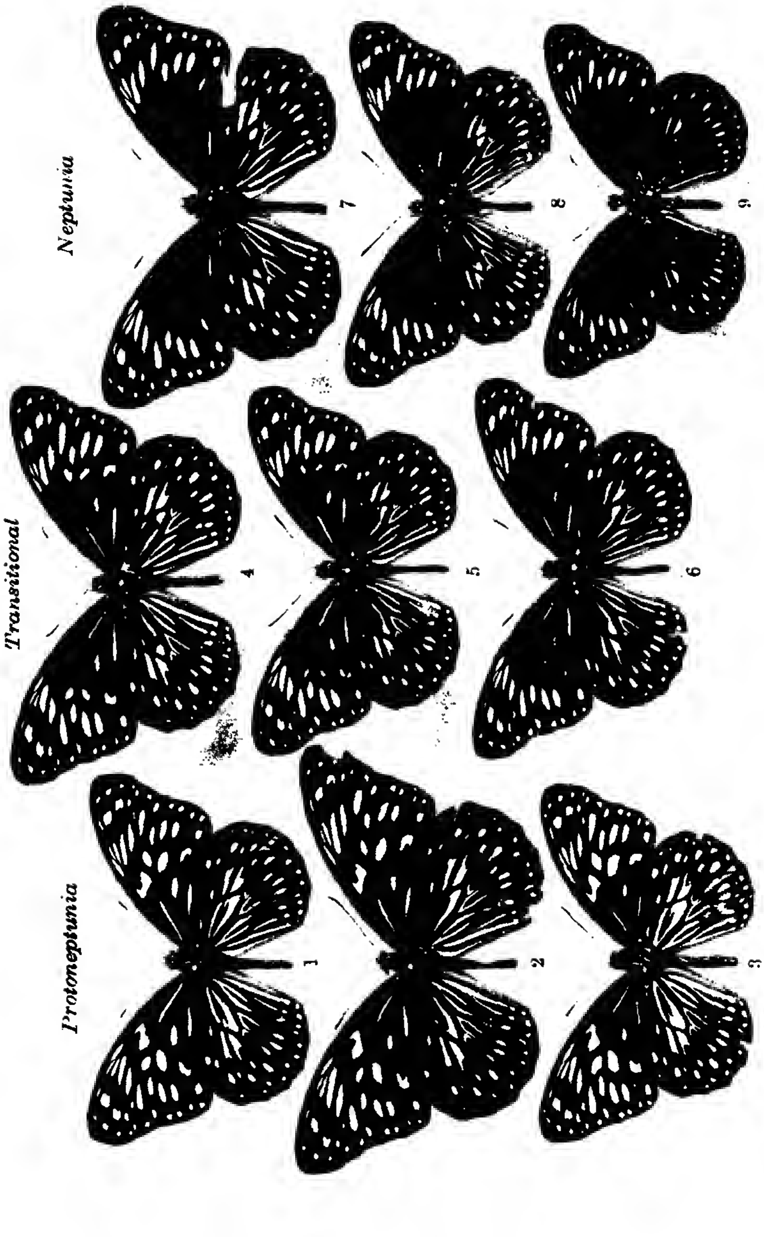
Helcita walkeri f. distincta

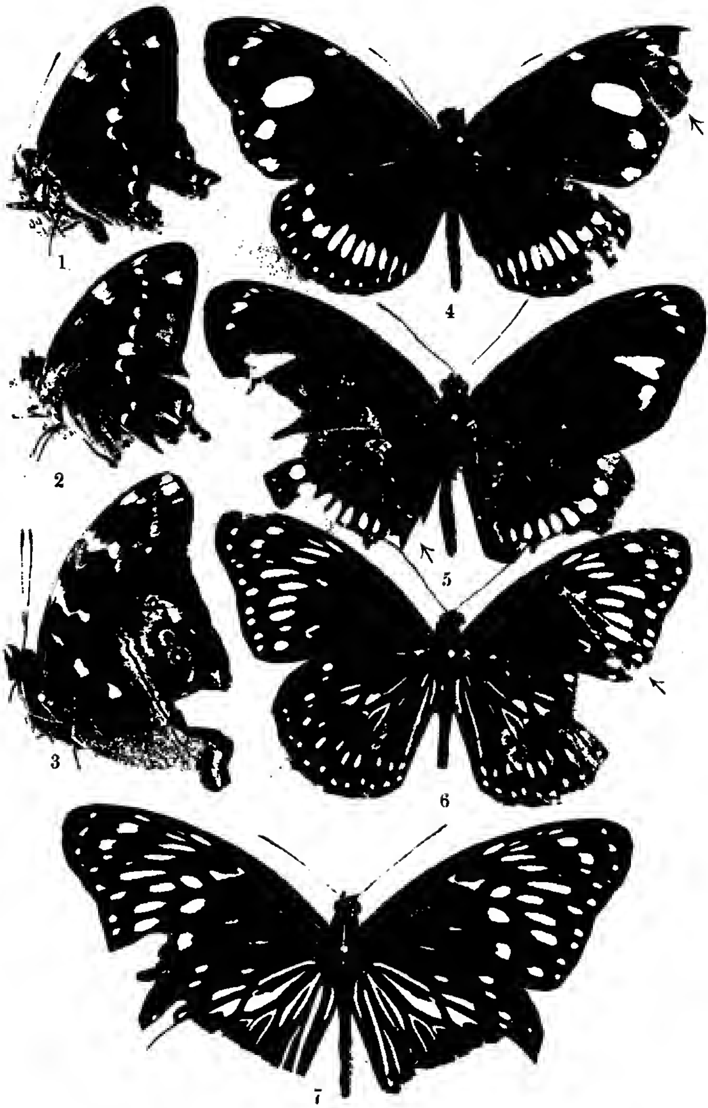
Helcita walkeri

A. Robinson, Photo. *Vaus & Crampton.*

All the figures are rather under ½ nat. size.

EUPLOEA HELCITA WITH REDUCED PATTERN (8–12) TAKEN WITH A DARK EUPLOEA (1–7) ON WALLIS I., BUT OF THE FORM WALKERI (13–19) ON FOTUNA I.


Protoneptunia
Transitional
Neptunia
1
2
3
4
5
6
7
8
9



A. Robinson, Photo. *Vaus & Crampton.*

All the figures are slightly under nat. size.

INJURIES INFLICTED BY BIRDS OR LIZARDS ON FIJIAN AND FOTUNA I. BUTTERFLIES. BEAK-MARKS DISTINCT ON 4–6.

FIJIAN HYPOLIMNAS BOLINA

All the figures are nearly ⅘ of the natural size.

Male (1, 1A), two forms of female (2, 2A, 3, 3A), pupa, larva, and food-p[lant]
from Suva

FIJIAN HYPOLIMNAS BOLINA

Like . Parent Y

FIJIAN HYPOLIMNAS BOLINA

FIJIAN HYPOLIMNAS BOLINA

Explanation of Plate LII.

Fijian *Hypolimnas bolina* (natural size).

Fam. 6.—*Female Forms (continued from Pl. LI) and Male, in Bisexual Family (including* 13 *Males) of Female Parent X, from Kandavu.*

For female parent X see Pl. LI, fig. 1.

Forms of Female Offspring (continued from Pl. LI) present in Family (with One Male).

Fig. 1. Two females of this form (*thomsoni*).
Fig. 2. One female of this form (*murrayi*).
Fig. 3. Two females of this form (*euploeoides*).
Fig. 4. One of the 3 males (out of 13) received.

The family included 5 additional females.

Explanation of Plate LIII.

Fijian *Hypolimnas bolina* (natural size).

Fam. 7.—*Female Forms in All-female Family of Female Parent W, from Kandavu.*

The female parent W, taken July 25, 1921, is of the form *euploeoides*, resembling fig. 1.

Forms of Female Offspring present in Family.

Fig. 1. Three females of this form (*euploeoides*).

Fig. 2. Three females of this form. One of them has slightly more and one slightly less of the "*nerina* red" on F.W. All are the same form as that shown in fig. 1, with this slight addition.

Fig. 3. Eight females of this form (*elliciana*, a *nerina* with reduced pattern).

Fig. 4. Two females of this form (*naresi*, with emphasised H.W. mark).

XXIX. *The Geographical Races of Heodes phlaeas* L. By

EDMUND B. FORD. Communicated by Comm. J. J. WALKER, M.A., R.N., F.L.S.

[Read December 5th, 1923.]

PLATE LIV.

CONTENTS.

A. GENERAL OBSERVATIONS.

THERE are comparatively few species of Diurnal Lepidoptera which have a wider range of distribution than *Heodes phlaeas* L. Throughout the greater part of the Northern Hemisphere this insect is to be found, extending southwards to the Ethiopian Region, while to the north it has been captured with four other species in Grinnell Land, at the highest latitude at which Rhopalocera have so far been obseived. It varies seasonably and geographically to a remarkable extent, and produces many striking and constant local raccs, while specimens from almost every district differ in some minute particulars which can be detected by the careful analysis of a long series. These variations have never been worked out with adequate material, and it is the object of this paper to consider them in relation to the distribution and seasonal dimorphism of the species. I am greatly indebted to Prof. E. B. Poulton, F.R.S., for suggesting this investigation in the first instance, and for his unfailing help ever since. It is entirely due to his kindness in placing the resources of the Hope Department of the University Museum of Oxford at my disposal that it has been possible to undertake it.

I should like to express my best thanks to Lord Rothschild, F.R.S., for entrusting to me, for many months, the whole of the unrivalled material from the Tring Zoological Museum; to Mr. J. J. Joicey, F.L.S., who so kindly sent for examination the extensive and interesting series from the Hill Museum, Witley, and to the authorities of the Natural History Museum, South Kensington, who gave me every opportunity of inspecting the unique specimens in the National Collection. I am most grateful to Dr. H. Eltringham for his kindness in preparing and painting the plate illustrating this memoir, and to Mr. Alfred Robinson for the trouble he has taken in photographing the specimens. To Commander J. J. Walker, R.N., F.L.S., I am indebted for many very valuable suggestions, also to Mr. G. T. Bethune-Baker, F.L.S., for giving me the opportunity of examining the remarkable and historic examples in his collection.

B. Seasonal Dimorphism.

The varieties of *Heodes phlaeas* may be regarded as coming under three headings: Geographical, Seasonal, and Casual Variation. It is with the first of these that this paper is chiefly concerned, but it is necessary to say something of the other two.

1. *Weismann's Experiments.*

Seasonal and geographical variation are not easily dissociated. In some localities the difference between the spring and summer broods is indeed most remarkable, in others it is almost imperceptible. Thus it will be convenient to consider some of the principal characters of seasonal variation at once, and to leave the others to be discussed in connection with the geographical distribution. Several authors have paid considerable attention to this subject, but the work of Weismann is the most detailed, and his experiments on the species are famous. He noticed that in Germany the spring and summer broods resemble one another, while in Italy they exhibit marked seasonal dimorphism; the spring brood being similar to the German, but the summer form having the wings more or less clouded with black, often almost to the exclusion of the coppery ground-colour. By subjecting to a high temperature the pupae obtained from a German spring form, he produced a brood darker than the normal, but not so dark as the

Italian specimens of the second generation; while, by subjecting pupae obtained from Naples to a low temperature at Freiburg, he produced a summer brood lighter than the Neapolitan insects, but darker than the German. His explanation of these results in the light of his theory of the germ-plasm is interesting. He says: "The germ-plasm of the Southern Colony must contain many determinants among those for the wings which, in consequence of the exposure of thousands of generations to heat, have been adapted for the production of black scales, together with a large number of others which only require a small increase of temperature during pupation in order to give rise to a black colour. These latter kind cause such fluctuations as occurred in my experiments; while the former produce the black coloration of the wings which has become fixed in the constitution of the Southern Colony, and can no longer be removed by the action of cold on the young chrysalis." *

2. *Various Observations: Constant and Racial Broods defined.*

Generally speaking, summer specimens are darker than spring or late autumn insects, sometimes extraordinarily so, and this tendency is, with few exceptions, accentuated progressively southwards. Frequently correlated with it is an increase in the length of the tail, situated at the end of the second nervure of the hind-wings, and more rarely of a pointed prolongation of the anal angle: both may be made more conspicuous by a deep indentation of the outer margin between them. This dark, long-tailed form is var. *eleus* F., but it is subject to such remarkable geographical variation that the name can only be regarded as having a vague general significance. Except in the far north, several broods of the species succeed one another during each year, the number depending generally on the locality and, to some extent, on the season. In favourable climates three, four or even more broods are the rule. These may be regarded as falling into two groups: the cold-weather forms, produced in the early spring and late autumn, which resemble each other, and the hot-weather forms, produced

* Weismann, "The Germ-plasm: a Theory of Heredity" (translated by Newton Parker and Rönnfeldt), p. 399 *et seq*. For a further account of these experiments see p. 420 of the same work and "Studies in the Theory of Descent" (translated by Raphael Meldola), pp. 49–50 and p. 54 *et seq*.

in the summer, which are also nearly alike. The spring and autumn specimens belong to what I have called the Constant Broods, and approximate to the typical form of the species, such as occurs in these islands; the summer specimens, which belong to what I have called the Racial Broods, are produced at a time when the high temperature and peculiar climatic conditions of a given locality can most readily act upon the pupa and produce their characteristic effects. These names are purely arbitrary, and are designed primarily to avoid circumlocution; nevertheless, in the great majority of cases, they have a considerable value in the study of this insect. I speak of Constant Broods because they are relatively constant in their appearance throughout the range of the species; of Racial Broods, because in them are manifested all the extreme forms of the local races. It will be seen, therefore, that specimens of *Heodes phlaeas* from any number of given localities resemble one another more closely in the Constant than in the Racial Broods. Setting aside the Occasional Aberrations, which occur indiscriminately in both, exceptions to this rule are very uncommon.

3. *The Climatic Effect on Racial Broods.*

Since the peculiar characteristics of the Racial Broods are the result of heat in the pupal stage, it follows that they must be more pronounced in hot seasons than in cool ones. In the south, where the insects are extensively suffused, a slight increase of dark pigment is not perceptible; further north, however, it produces a marked effect. In such a climate as that of England the ground-colour generally remains fairly bright at all times. When three broods occur they are hardly to be distinguished from one another, though nearly always the second, which is really the Racial Brood, is slightly duller than the other two. It is only in exceptional circumstances that it really differs from them, and we see operating here the same process which produces such striking seasonal dimorphism further south. There are in the Hope Department at Oxford most remarkable illustrations of this climatic effect. Dr. R. C. L. Perkins, F.R.S., captured thirty-seven specimens on the same bank at Cerne Abbas, Dorset, twenty-one in August 1911, one of the hottest years within living memory, and sixteen in August 1912, one of the

coldest and wettest. They are of unusual interest, all belong to the Racial Brood, and eight out of the fourteen 1911 males are darker than any of the eight males taken in 1912, while, in both sexes, the copper tint is more brilliantly lustrous in 1912 than in 1911.* During the present year (1923) Mr. A. H. Hamm has captured a series of one hundred and fifty-five specimens at Hogley Bog, Bullingdon, Oxford. They show that even in the most unfavourable seasons the second brood is slightly darker than the others. He has carefully supplied them with the most minute data. Seventeen captured on June 23rd are bright and fiery, with the spots on the fore-wings very small. By August 19th a second brood had appeared, and the sixty-two specimens captured on that day are distinctly dull and present a striking contrast to the earlier insects. The thirty-nine specimens captured on August 26th show the same characteristics, but on September 2nd, among twenty insects, are six very bright newly emerged examples. These may be a retarded emergence or, more probably, a third brood; in either case they show in a marked manner the effect which the unusual cold at the end of August exercised on the pupa. On September 9th eight specimens out of seventeen show the same effect. Another interesting series of one hundred and three specimens, captured near Newbury in September 1921, also by Mr. Hamm, provides an excellent example of a third brood in this country.† In that summer, which was throughout very hot, the ground-colour of the second brood was quite dull, but that of the third is as bright as any spring specimens, thus illustrating the similarity of the two Constant Broods.

It should be noticed that in all cases the male is much more strongly affected by heat in the pupal stage than the female; so that in those southern localities, where the suffusion is very great, *Heodes phlaeas* becomes, in the Racial Broods, a sexually dimorphic butterfly. Differences of shape and size also appear: this is to some extent a geographical effect, for it is more pronounced in the Far East than in the West, even though the quantity of suffusion may be less.

* Proc. Ent. Soc. Lond., 1912, p. cxxxviii.

† For a further account of these specimens see Proc. Ent. Soc. Lond., 1921, p. cvi.

C. Occasional Aberrations.

1. *Some of the named Forms.*

There are a certain number of Occasional Aberrations which may appear in any brood or in any locality. In what are, perhaps, the most striking examples of these the copper is replaced by a yellowish-white or cream colour (ab. *schmidtii* Gerhart; Plate LIV, fig. 7) or by a pure white (ab. *alba* Tutt; Plate LIV, fig. 13). They are the end result of a long series of variations graduating imperceptibly from the normal copper ground-colour, among which ab. *cuprinus* Peyer, *intermedia* Tutt, and some others have received names. Not infrequently individuals appear with one white or brass-coloured wing; generally they are not to be regarded as asymmetrical examples of the normal varieties, but are pathological in origin, for the wing appears bleached in many cases, and the scales may be twisted or otherwise deformed. On the other hand, the ground-colour may remain typical, while the spots on the fore-wings alter in tone, to grey in ab. *webbi* Tutt, or to white in ab. *huebneri* Tutt. These spots may vary in size and shape in a highly remarkable manner. They may be greatly reduced in number, so that the fore-wings are entirely coppery save for the black border and the two cell-spots (ab. *bipunctata* Tutt), and ultimately even these disappear in ab. *obliterata* Scudder. The spots of the distal series are, however, frequently enlarged (ab. *magnipunctata* Tutt) until they touch one another (ab. *koebi* Stgr.), and finally coalesce into a continuous band in ab. *fasciata* Streck. They may be oval in shape or modified into streaks, with which the cell-spot occasionally unites (ab. *conjuncta* Tutt). These aberrations are frequently repeated on the underside or may occur on that surface alone. The red band at the margin of the hind-wings is somewhat rarely broken up into a series of wedge-shaped markings (ab. *radiata* Tutt), and may even disappear completely (ab. *obsoleta* Tutt). Sometimes, however, it is abnormally broad or may be continued in streaks up the nervures (ab. *subradiata* Tutt). A character which is racial in one locality may be found in others as an occasional aberration. For example, in Western Europe a form appears now and then in which the usual copper is replaced by a fiery red (ab. *ignita* Tutt), yet this is a normal

feature of the race occurring in the Tian-Shan. These various modifications are almost endless, and a large proportion of them have received names. It would be profitless to repeat these here, as many refer to examples which are intermediate in some degree between the type and the more extreme aberrations cited above. They may all be found, when required, in an excellent article on this species by the late Mr. J. W. Tutt.*

2. *Caeruleo-punctata* Stgr.

Before leaving this subject, the blue spots so often seen immediately within the red band on the hind-wings (var. *caeruleo-punctata* Stgr.) deserve consideration. It is not often that they form a very important factor, for they appear and disappear in a very confusing manner even in the most striking and constant local races. Two forms are, so far as is known, exceptional in this respect: in *aethiopica* Poulton,† they are a constant feature, and they do not occur in the Racial Broods of China. It has been suggested that they occur in a larger percentage of specimens from marshes than from dry ground, and an interesting discussion on this subject is to be found in the Entomologist.‡ The evidence there brought forward seems conflicting, and I cannot say that my own observations have in any measure corroborated this theory. It appears to me that, if *caeruleo-punctata* were the form of the species inhabiting damp places, we might reasonable expect to find an increase in the percentage of specimens exhibiting blue spots in districts where the rainfall is heavy and marshes are frequent, and, conversely, a decrease in this percentage among a large random selection from drier countries. From the data given later in this paper it will be found that such is not the case. Mr. Hamm has also come to the same opinion, for, speaking of a series which he captured on Greenham Common, "one of the highest and driest places near Newbury," he remarks: "A few are of the *caeruleo-punctata* form, a variety supposed to occur more frequently in damp situations, but here as common in the high and dry locality as in the others." §

* "A Natural History of the British Lepidoptera," vol. viii, p. 330 *et seq.*

† See p. 703.

‡ Entom., vol. liii, pp. 233, 284, 285; vol. liv, pp. 17, 101; vol. lv, p. 36.

§ Proc. Ent. Soc. Lond., 1921, p. cvii.

In the article previously cited, Mr. Tutt deals with this aberration at some length. He quotes a reference to a paper by Weismann translated in the Entomologist,* and, after transcribing fairly closely, continues : "If specimens from the south be compared with those from the north, it is seen that well-developed [blue] spots and their indications are much more frequent, but that no correspondence exists between climate and degree of perfection of the spots." The opinion here expressed is contrary to my own observations, for I have been unable to detect any correlation between the latitude and the frequency of the *caeruleo-punctata* form. To illustrate this point I have selected, from the following data, eight localities, all in the western part of the Palaearctic Region, and have arranged them according to their latitude.

Locality.	The *caeruleo-punctata* form.	
	Constant Broods.	Racial Broods.
Uddevalla (Sweden)	—	35%
Bullingdon, Oxford	18%	17%
Bihar Comitat (Hungary)	19%	24%
France (Mediterranean Coast)	29%	28%
Sicily	?	18%
Algiers (Town)	18%	12%
Cyprus	41%	47%
Southern Algeria	21%	?

It will be seen that the proportions in which the *caeruleo-punctata* form occurs are quite irregular, but that they do not differ widely in the two types of brood from the same place; exceptions to this rule are uncommon. It is noteworthy, also, that in some localities the higher numbers occur in the Constant Broods, in others in the Racial: a condition very different from that obtaining in regard to the Critical Spot (pp. 731–732).

The above examples may be amplified from the data given later in this paper, where a description will be found of the forms occurring in very numerous localities throughout the range of the species, and the percentage in which the blue spots appear is there recorded in each case. Weis-

* Entom., vol. xxix, pp. 74–75.

mann seems definitely to have held the same opinion in regard to the lack of correlation between the *caeruleo-punctata* form and the latitude, for on turning to the article mentioned above I find, in place of the passage given by Tutt, the following: "If specimens from the south are compared with those from the north, it turns out that well-developed spots occur in individuals everywhere, that indications of them are frequent everywhere, but that no correspondence exists between the climate and the degree of perfection of the blue spots." I do not know whether Tutt misread the passage or was drawing his own conclusions from Weismann's data.

D. The Geographical Races.

1. *General Remarks: previous work.*

To turn, however, to the geographical races. Mr. Tutt remarks that "The variation of *Rumicia* [*Heodes*] *phlaeas* is one of the most difficult subjects with which we have to treat," and this has generally been recognised by entomologists. It is to be accounted for in part by the seasonal dimorphism, which varies from year to year and is extreme in some localities, almost unnoticeable in others, but chiefly by the nature of the local races. Some are most striking, and often have certain features common to them at all times of the year with others superimposed, as it were, on the Racial Broods; in other places it is these broods alone which are remarkable. More frequently slight though constant changes of colour are the only distinctions perceptible, while often the geographical forms are due to a shifting of the average in some small respect. It is not surprising that they have always attracted attention, and entomological literature contains many interesting observations upon individual races and one or two more general surveys, among the most valuable of which are: that part of Mr. Tutt's great work on British Lepidoptera which deals with this species; * the article on *Heodes phlaeas* in "The Macrolepidoptera of the World," by Dr. Seitz; † and a paper by Dr. Chapman in the Entomologist's Record.‡ The

* "A Natural History of the British Lepidoptera," vol. viii, p. 330 *et seq.*

† "The Macrolepidoptera of the World," Section 1. The Palaearctic Region (translated by Dr. K. Jordan), vol. i, pp. 285–286.

‡ The Entomologist's Record, 1904, vol. xvi, p. 167 *et seq.*

first of these is an admirable and comprehensive account of the species, giving most minute particulars of the Occasional Aberrations, but, being a work on British Lepidoptera only, the various Geographical Races are not fully dealt with. The able passage in "The Macrolepidoptera of the World" above referred to is necessarily very short, and the same remark applies to Dr. Chapman's paper, in which I find the following observation: "The greatest variation in colour occurs in the amount of black scaling. This occurs in two very distinct ways, viz., by greater extension of the black areas, spots, hind margin, etc., and by a suffusion of black scales. The former not unfrequently occurs with hardly any of the latter, but suffusion of the copper is almost always associated with some increase of the black areas. The evidence of the specimens submitted is to the effect that both these are the result of heat in the earlier stages, that is, that it is entirely climatic and in no definite way geographical or racial."

It is certainly true that the amount of suffusion on the fore-wings is subject to the most extraordinary variation, that it is of the two types described by Dr. Chapman, and that it is the result of increased heat in the earlier stages. The study of large collections from numerous localities makes it appear, however, that its character is dependent on the Geographical Races to a very considerable degree. Thus in Italy and Syria the fore-wings of the Racial Broods are extensively suffused, the exact amount depending on the individual, the sex and the season. Though this suffusion takes place on parallel lines in the two localities, it is always perfectly distinct. The rich black of the Italian specimens could never be confused with the dull lustreless brown of the Syrian forms by anyone who has once examined them.

2. *The Range of the Species.*

In order to obtain sufficient data for the following account of the Geographical Races of *Heodes phlaeas* I have examined minutely between four and five thousand specimens from its entire range, and many others sufficiently to ascertain whether they are true to the form which is typical of their locality. The species occurs practically through the whole of the Palaearctic and Nearctic Regions, as well as the northern part of India in the Oriental Region. Within the Continent of Europe the Geographical Races are

often separable only by comparatively small details. Excluding the Arctic forms they are to be distinguished more by a change of the average in some slight respect than by any outstanding characters, although the Racial Broods of the south are, broadly speaking, very different from those of the north, owing to the greater amount of suffusion of the fore-wings in the former. This general uniformity offers a surprising contrast to some of the remarkable races which occur in other parts of the world.

3. *The Ethiopian Forms.*

The only portion of the insect's range with which this paper does not deal is the Ethiopian Region, where it is found in three very singular forms—*abboti* Holland, *pseudophlaeas* Lucas, and *aethiopica* Poulton. The whole question of their occurrence has been discussed very fully by Prof. Poulton,* so that it is unnecessary to deal with the matter here. I might add, however, for the sake of completeness, that they are quite unlike any other known forms, with the possible exception of one or two specimens captured far to the south near the western border of the Sahara.† The three forms differ considerably from one another, but in general it may be said that the copper ground-colour has a very distinctive tone: it is rather pale, of a very curious brickdust shade, and strongly metallic. The copper band near the margin of the hind-wings is unusually broad, and these wings are themselves more or less thickly dusted with metallic scales up to the base. On the underside their colour is a rich red-brown, which is quite characteristic. It is a singular fact that here, at the southern limit of the species, no examples have been recorded which show the smallest trace of suffusion.

4. *The Genitalia.*

Dr. Chapman has made a report on the genitalia of these Ethiopian forms.‡ He finds that they do not differ from those of *H. phlaeas phlaeas* save in a slight diminution in size, which is most noticeable in the aedoeagus, "which is 2·0 to 2·1 mm. long in Northern *phlaeas* and 1·63 to 1·75 in the African forms." There is also a greater constancy in

* Proc. Ent. Soc. Lond., 1921, pp. lxxxi–lxxxvi; 1922, pp. li–lvi and xciv–xcv; also, 1923, pp. xxii–xxiv.

† *Ibid.*, 1923, pp. xxiv–xxv. See also p. 719 of this memoir.

‡ *Ibid.*, 1921, p. lxxxii *et seq.*

the outline of the penis sheath. He says, " It is possible to regard these as specific characters. For my own part I regard them as items of geographical variation, still far short of implying specific distinction. . . ." He then proceeds to state his conclusions on a matter intimately connected with this present paper—the relation between *H. phlaeas phlaeas* and *H. phlaeas hypophlaeas.* He examined the genitalia of these two forms and remarks: " I may say that I regard *hypophlaeas* (Lapland and N. America) as specifically identical with *phlaeas.* The appendages don't differ at all. . . ."

5. *Methods used in describing the Geographical Races.*

In describing the various local forms I have, of course, relied upon the abnormal and distinctive characters which they may possess. Frequently, also, I have made use of one or two modifications of the ordinary shape and markings; such as the length of the tail, the quality of the suffusion and the area of the wing which it covers, when present; also the colour of the underside of the hind-wings and any markings thereon. One of the most interesting of these distinctions is the shape of the first spot in the distal series above the hind margin of the fore-wings, situated between nervures 1 and 2. Prof. Poulton has shown the value of this character in describing the Ethiopian forms of the species. For the sake of brevity I shall refer to it as the *Critical Spot.* It is comparatively long and narrow; its form is essentially double—this is more clearly seen on the underside but, even above, it may be divided into two distinct spots. It may be constricted hour-glass-like, but normally its shape is crescentic and its direction variable. When the concavity faces outwards I shall simply refer to it as *turned out*; when it faces inwards I shall call it *turned in.* That is to say it is the concavity, not the convexity, which is always referred to. If a large number of specimens from all broods be captured in a given locality, it will be found that the percentage having the Critical Spot definitely turned inwards and definitely turned outwards is fairly constant. These proportions differ widely in the various local forms, in complete accordance with Prof. Poulton's expectation that, when sufficient material could be obtained, the shape of this spot would prove to be a racial character.* In every district its direction is doubtful in a

* Proc. Ent. Soc. Lond., 1922, p. liv.

certain number of specimens, and in a few instances it is divided into two.

In describing the Geographical Races of *Heodes phlaeas,* I have attempted to follow, as far as possible, a linear order, tracing the variations from one country into the next. It is, of course, impossible to carry out such a plan completely. Starting with Britain I have followed with France, taking the Channel Islands on the way, then through Spain (with Majorca) into Portugal. Commencing again with the coast of the Baltic I have discussed the forms to be found in Germany, Hungary, Switzerland, the Italian Peninsula and the adjacent islands. From this point I have described the races inhabiting the countries bordering the Mediterranean, travelling east along the north coast and west to Morocco along the south, completing the western habitat with the Canary Islands and Madeira. In Asia I have followed an imaginary line running east from Syria to the coast of China, deviating north or south on the way when necessary, and completing the Palaearctic Region with Corea and Japan. After giving an account of the Oriental and Nearctic Races, I have devoted a section at the end of the paper to the circumpolar forms; for their affinities can be determined more readily when the eastern part of the Palaearctic Region has been dealt with. Furthermore, by their study we gain some light on the origin of *H. phlaeas hypophlaeas* in North America.

E. The Palaearctic Region.

I. Europe and the Mediterranean Coast.

Owing to the small differences which are observable among the races of Europe and the Mediterranean coast a standard form of description is necessary. The Constant and Racial Broods will be kept distinct, though as the former hardly vary within the limits of this section, they will only be considered fully in a few instances. In each locality I have recorded the percentages, to the nearest whole number, in which the Critical Spot is turned in and out, giving in addition the data from which they were calculated. They rarely amount to 100%, since, in almost every case, their direction is doubtful in many specimens. When less than twenty-five examples of a brood have been obtainable I have recorded only the actual numbers. When the tail is mentioned in the following descriptions,

without explanatory remarks, it is the true tail, situated at the end of the second nervure, which is referred to; not a pointed prolongation of the anal angle. In the region under discussion, the markings on the lower surface of the hind-wings, which form such a crucial test elsewhere, are constant and uninteresting. It will be convenient, therefore, to describe them forthwith, and to omit further reference to them save in exceptional cases.

Under Surface of the Hind-wings.—In the Constant Broods the ground-colour is generally a slate-grey on which a series of dark spots may be seen with some distinctness; there is in some specimens a trace of a red line within the margin. In the Racial Broods the ground-colour is of a more uniform brown or whitish brown, the black spots are less distinct, and traces of a red line are less common. In those districts where the Racial Broods are much suffused these two types of underside are very constant and distinct. In the north, however, they merge into each other imperceptibly, so that they are not more easily separable on the lower surface than on the upper.

I have generally had the opportunity of examining large captures from one or two localities in each country, and these have been described in full. Usually, however, small numbers from very many different places have also been studied, and it would, of course, be impossible to deal with all these separately. I have therefore grouped them into districts, both for the purpose of a general description as well as of calculating the percentages of the Critical Spot and of the *caeruleo-punctata* form. Where, however, any specimens appear at all remarkable I have also given a separate account of them. Thus the trend of variation can be traced through each country, and can be considered in relation to the description of large collections from a few distinct localities. This plan only holds good for the present section, after which it has been necessary to modify it very considerably.

1. Britain.

Distributed from the Orkney Islands southwards, and throughout Ireland. The distinction between the Constant and Racial Broods, and the effect of the climate on the latter, has already been discussed (pp. 695–697). It is very

rarely that extensively suffused specimens occur, and then of course only in the Racial Brood, which, with us, is the second. Such specimens are naturally more frequent in warm years than in cold ones, but even in the most unfavourable circumstances a few hot days towards the end of the pupal period may have a marked effect. Thus Prof. Poulton captured one specimen on August 14th this year (1923) in the Isle of Wight which is extraordinarily dark, having been affected by the heat during the first fortnight of the month. It is rare to find the tail more than very slightly developed.

The distribution of *Heodes phlaeas* in these islands has been described far more minutely than in any other part of the insect's range. It is not my intention, therefore, to reoccupy a field of work which has been so thoroughly explored. The most elaborate information may be found on this subject in Mr. Tutt's work,* which has previously been cited. I have, however, calculated the percentage in which the Critical Spot is turned in or out in two localities from which a considerable number of specimens have been examined.

Bexley (*Kent*).

Constant Brood (May to July, those from the latter month are not particularly good specimens). 309 examined. Critical Spot: *out*—156 (50%), *in*—36 (12%). *Caeruleo-punctata*—63 (20%).

Hogley Bog, Bullingdon, Oxford.

Constant Brood. 28 examined. Critical Spot: *out*—13 (46%), *in*—10 (36%). *Caeruleo-punctata*—5 (18%).

Racial Brood. 127 examined. Critical Spot: *out*—56 (44%), *in*—41 (32%). *Caeruleo-punctata*—22 (17%).

2. The Channel Islands.

Guernsey.

Constant Brood. 11 specimens examined. Critical Spot: 10—*out*, 0—*in*. *Caeruleo-punctata*—9. All are unsuffused, and the ground-colour is very bright. None have tails.

Racial Brood. 4 specimens examined. Critical Spot: 1—*out*, 2—*in*. *Caeruleo-punctata*—4. These are slightly

* "A Natural History of the British Lepidoptera," vol. viii, p. 330 *et seq.*

suffused, and the copper is rather dull; there is a trace of the tail in all.

3. France.

In the north the species hardly differs from the form to be found in England; in the south the Racial Broods become greatly suffused.

Northern France.

Constant Brood. 7 specimens examined. Critical Spot: 2—*out*, 3—*in*. *Caeruleo-punctata*—5. All are quite bright and unsuffused.

Racial Brood. 11 specimens examined. Critical Spot: 0—*out*, 6—*in*. *Caeruleo-punctata*—4. There is a trace of the tail, and the copper is dull.

Central France.

Constant Brood. 13 specimens examined. Critical Spot: 6—*out*, 2—*in*. *Caeruleo-punctata*—5. All are bright and tailless.

Racial Brood. 24 specimens examined. Critical Spot: 6—*out*, 15—*in*. *Caeruleo-punctata*—4. It is here that deeply suffused forms begin to appear, so that the characters of this brood are very unstable—some being coppery, others extremely dark. In a few the tail is well developed.

The Mediterranean Coast.

Constant Brood. 38 examined. Critical Spot: *out*—24 (63%), *in*—6 (16%). *Caeruleo-punctata*—11 (29%). In the spring the insects begin to emerge in March. They are generally very small and always bright.

Racial Brood. 58 examined. Critical Spot: *out*—13 (22%), *in*—32 (55%). *Caeruleo-punctata*—16 (28%). These are generally very dark, the suffusion being of a rich black shade, and, where copper scales appear, they are very fiery. The tails are long, and the spots on the fore-wings are often much enlarged.

The Pyrenees.

Racial Brood. 17 specimens examined. Critical Spot: 8—*out*, 4—*in*. *Caeruleo-punctata*—5. They show very clearly the effect of altitude on *H. phlaeas*. Though one or two specimens are dark, the suffusion is much less than at the same latitude on sea-level; the tails are shorter

and the spots on the fore-wings smaller. For instance, one specimen in Mr. Bethune-Baker's collection captured on Mont Louis, 5,280 ft., 28 vii.–5 viii. 1922, is very bright.

4. Spain and Portugal with Majorca.

Spain (excepting Segovia and the Gibraltar District).

A few specimens from numerous localities; they do not appear to differ from one another.

Racial Brood. 47 examined. Critical Spot: *out*—10 (21%), *in*—21 (45%). *Caeruleo-punctata*—10 (21%). The size seems to vary considerably; all are much suffused and have long tails. The underside of the hind-wings is of a whitish-brown tint.

Segovia (the Sierra de Guadarrama).

Racial Brood. 233 examined. Critical Spot: *out*—92 (39%), *in*—66 (28%). *Caeruleo-punctata*—35 (15%). The suffusion is rich and black, its degree varies greatly. Some are quite bright, while, in others, the copper is almost completely obscured. The tails are long. The spots on the fore-wings are large and sometimes meet the marginal band.

Gibraltar and the South Coast (to the Portuguese Boundary).

Constant Brood. Only 7 examined. Critical Spot: 5—*out*, 1—*in*. *Caeruleo-punctata*—2. These specimens are very small and bright, the dark markings and spots are pale. This brood begins to emerge at the end of January.

Racial Brood. 16 specimens examined. Critical Spot: 7—*out*, 6—*in*. *Caeruleo-punctata*—7. Exceedingly dark and suffused. In a small proportion of the females there is no great amount of black scaling, but they are always large, and the copper is very dull. The underside of the hind-wings is, in all, a whitish brown.

Majorca.

Constant Brood. 2 specimens. Critical Spot: direction doubtful. *Caeruleo-punctata*—1. Very bright and unsuffused, but of considerable size for a Constant Brood.

Racial Brood. 14 examined. Critical Spot: 6—*out*, 6—*in*. *Caeruleo-punctata*—6. In spite of the fact that

I have seen one or two dwarfs from the island the specimens are generally rather large and have long tails. The copper is dull and is often heavily suffused.

Portugal. Algarve District.

Constant Brood. 24 examined. Critical Spot: 18—*out*, 3—*in*. *Caeruleo-punctata*—2. The colour is bright and tails are practically absent.

Lisbon.

Racial Brood. 5 specimens examined. Critical spot: 0—*out*, 4—*in*. *Caeruleo-punctata*—4. The tails are long and the copper is extensively suffused.

5. The Coasts of the Baltic.

Uddevalla, South Sweden.

Unfortunately the specimens which I have examined from this locality (26 in all) are undated. Almost certainly they are July or August examples: it is probable that two broods occur there. Critical Spot: *out*—9 (35%), *in*—5 (19%). *Caeruleo-punctata*—9 (35%). It is singular to find that two are slightly suffused. There is quite a distinct trace of the tail. The underside of the hind-wings is partly overspread with a hoary grey tint in one or two specimens. It is probably beginning to assume the characteristics of one of the far-northern forms to be described later (p. 739).

Russia. Petrograd District.

Racial Brood. Only 3 examined. In all the Critical Spot is turned in. One is of the *caeruleo-punctata* form. The specimens are rather large; in one the copper is slightly dull, though there is no trace of suffusion. The underside of the hind-wings is a greyish brown and the red line is not developed.

Russia. Wolmar.

One specimen, probably July or August, is a very remarkable aberration. The copper is replaced by a dull yellowish-brown shade, and the spots on the fore-wings are greatly reduced. The Critical Spot is practically absent, a very rare occurrence.

Denmark.

Only 5 examined. They belong to a Racial Brood. Critical Spot: 2—*out*, 2—*in*. *Caeruleo-punctata*—0. All are rather large and bright.

6. Germany, Austria, and Hungary.

Prussia.

Constant Brood. 4 specimens examined. Critical Spot: 1—*out*, 1—*in*. *Caeruleo-punctata*—1. Small and bright.

Racial Brood. 14 specimens. Critical Spot: 6—*out*, 7—*in*. *Caeruleo-punctata*—3. The copper is slightly dull. One specimen from Berlin is a beautiful example of ab. *schmidtii* Gerhart, markedly suffused (Plate LIV, fig. 7.).

South-western Germany.

Racial Brood. 16 specimens examined. Critical Spot: 2—*out*, 6—*in*. *Caeruleo-punctata*—6. The copper is fiery and in one case deeply suffused.

North-western Austria.

Constant Brood. 22 examined. Critical Spot: 12—*out*, 3—*in*. *Caeruleo-punctata*—5.

Racial Brood. 32 examined. Critical Spot: *out*—10 (30%), *in*—13 (39%). *Caeruleo-punctata*—6 (18%). In many of these specimens the basal area of the fore-wings is suffused. The tails are long.

Western Hungary.

Constant Brood. 5 specimens examined. Critical Spot: 2—*out*, 0—*in*. *Caeruleo-punctata*—2.

Racial Brood. 11 specimens examined. Critical Spot: 4—*out*, 5—*in*. *Caeruleo-punctata*—1. Several are very dark, and the tails are generally long.

Bihar Comitat, Hungary.

Constant Brood. 27 examined. Critical Spot: *out*—15 (56%), *in*—4 (15%). *Caeruleo-punctata*—5 (19%). Bright, with the spots on the fore-wings reduced in size. The red band on the upperside of the hind-wings tends to become broad.

Racial Brood. 108 examined. Critical Spot: *out*—27 (25%), *in*—49 (45%). *Caeruleo-punctata*—26 (24%). In

these specimens the copper is dull, and many are slightly suffused. Tails are generally present, but short.

7. Switzerland.

None are from far north of the Italian border, and all have been captured from low elevations up to 2,750 ft.

Constant Brood. 7 specimens examined. Critical Spot: 6—*out*, 0—*in*. *Caeruleo-punctata*—4. These are small and bright.

Racial Brood. 11 specimens examined. Critical Spot: 4—*out*, 5—*in*. *Caeruleo-punctata*—5. A few are considerably suffused; the remainder are rather large, and the copper is dull.

8. Italy.

The Plain of Lombardy.

Constant Brood. 36 examined. Critical Spot: *out*—14 (39%), *in*—5 (14%). *Caeruleo-punctata*—4 (12%). Very bright and fiery.

Racial Brood. 7 specimens examined. Critical Spot: 3—*out*, 3—*in*. *Caeruleo-punctata*—5. The copper is dull, and in some specimens suffused. The tail is exceedingly small.

Southern or Peninsular Italy.

Constant Brood. 5 specimens examined. Critical Spot: 2—*out*, 0—*in*. *Caeruleo-punctata*—1. Small and bright.

Racial Brood. 48 examined. Critical Spot: *out*—24 (50%), *in*—21 (44%). *Caeruleo-punctata*—7 (15%). In this brood the insects are much suffused, their colour being very black and glossy, a small patch of brilliant copper often stands out in the centre of the fore-wing. The tails remain small.

Florence.

Constant Brood. 69 examined. Critical Spot: *out*—36 (52%), *in*—24 (35%). *Caeruleo-punctata*—29 (42%). In these broods (from the spring and autumn) the ground-colour is bright and the red band on the upperside of the hind-wings is unusually broad. The spots on the fore-wings are very small.

Racial Brood. 10 examined. Critical Spot: 3—*out*,

6—*in*. *Caeruleo-punctata*—4. These are exceedingly suffused, the males having practically no copper on the upper surface. A trace of the tail appears.

Elba.

Racial Brood. 5 specimens examined. Critical Spot: 0—*out*, 3—*in*. *Caeruleo-punctata*—2. The males are much suffused, but the only female has no great increase in the black scales, though the copper is very dull. The tails are distinct, though not long.

Corsica.

Racial Brood. 67 examined. Critical Spot: *out*—18 (27%), *in*—40 (60%). *Caeruleo-punctata*—36 (54%). Unfortunately I have seen no Constant Brood specimens from this island. In all cases the copper is fiery and rather dull, often there is extreme suffusion. One rather interesting example in the Hope Department, from a locality near Bocognano, 27 vii. 1911, is quite bright and unsuffused, illustrating the effect of the altitude at which it was captured—2,205 ft.

Sardinia.

Unfortunately I have only seen one specimen from this island. It is of the Racial Brood (though without data). The Critical Spot is turned in and there is a trace of the blue spots. It is exceedingly black and suffused, though the little copper that remains is fiery. The tails are longer than in any specimen I have seen from Italy, Elba, or Corsica.

Sicily.

Constant Brood. Only 11 seen. Critical Spot: 9—*out*, 0—*in*. *Caeruleo-punctata*—5. These are bright and typical in appearance.

Racial Brood. 56 examined. Critical Spot: *out*—32 (57%), *in*—16 (29%). *Caeruleo-punctata*—10 (18%). There is a remarkable development of the tails, which are noticeably longer than in Italian specimens. In the Tring Zoological Museum are ten examples captured above Randazzo, on the slopes of Mt. Etna, at about 3,000 ft. Among them is a dwarf, 24 mm. in expanse; average males being 26–27 mm. in this island. This specimen is suffused and has long tails; indeed, it has all the characteristics of its brood.

9. Malta.

Constant Brood. Only 2 specimens seen. Critical Spot: both *out.* They are of the *caeruleo-punctata* form. These two insects are small and bright with a very broad band on the upper surface of the hind-wings.

Racial Brood. 12 specimens examined. Critical Spot: 8—*out,* 1—*in.* *Caeruleo-punctata*—0. They are not much suffused, but the copper is rather dull; the tails are long. It is curious to find that such a large percentage of the Racial Brood both in Sicily and Malta have the Critical Spot turned outwards, contrary to the condition obtaining in the neighbouring countries.

10. The Mediterranean Coast East of Italy to the Levant, with the Balkans.

Orsova.

Racial Brood. 3 specimens examined. Critical Spot: 0—*out,* 2—*in.* *Caeruleo-punctata*—2. Exceedingly dark and somewhat brown. The tails are long.

Corfu.

Racial Brood. 3 specimens. Critical Spot: 0—*out,* 2—*in.* *Caeruleo-punctata*—0. The suffusion, which is extreme, is of a dull brown colour and the few copper scales are yellow and lack the metallic brilliancy. This is characteristic of the forms east of Italy and is noticeable in an increasing degree as far as Syria, after which Asiatic characters appear. The tails are long.

Greece.

Racial Brood. 36 specimens. Critical Spot: *out*—13 (36%), *in*—12 (33%). *Caeruleo-punctata*—6 (17%). These specimens have very long tails and are deeply suffused.

Salonica.

Constant Brood. 2 specimens. Critical Spot: 1—*out,* 1—*in.* *Caeruleo-punctata*—0. Large but bright and unsuffused; they have no tails.

Bulgaria (Balkans).

Racial Brood. Unfortunately I have seen but one specimen from this country. Critical Spot: *in.* *Caeruleo-*

punctata—0. The tails are vestigial. This insect is considerably suffused, but the remaining copper is pale.

Turkey (Balkans).

Racial Brood. 3 specimens. Critical Spot: all *in.* Deeply suffused; the copper is very yellow and lustreless.

Asia Minor.

The South-western Coast.

Racial Brood. 41 examined. Critical Spot: *out*—15 (37%), *in*—23 (56%). *Caeruleo-punctata*—8 (20%). The males are deeply suffused with brown. The band within the outer margin of the hind-wings is narrow but brilliantly red in tone; the tails are very long. The females are comparatively little suffused, the copper is pale and the dark areas and spots brown. The sexes are, thus, strongly dimorphic. (Plate LIV., fig. 18, male.)

Amasia (40° 39′ N., 35° 51′ E.).

Racial Brood. I have only examined one specimen from this place. The Critical Spot is turned *in*, and there are blue spots on the hind-wings. The specimen is considerably suffused and is much below the average size.

Syria and Palestine.

Constant Brood. 6 specimens examined. Critical Spot: 5—*out*, 1—*in*. *Caeruleo-punctata*—5.

Racial Brood. 25 examined. Critical Spot: *out*—4 (16%), *in*—16 (64%). *Caeruleo-punctata*—10 (40%). Here the difference between the Constant and Racial Broods is most striking. The former are very bright and rather small; the underside of the hind-wings is a greyish brown. The specimens of the Racial Brood, on the other hand, are large, suffused and dull. In the females, particularly, the copper is lustreless and somewhat yellow, giving to the sexes a remarkably distinct appearance. The underside of the hind-wings is a whitish brown. The tails are unusually long.

11. Cyprus.

Constant Brood. 34 examined. Critical Spot: *out*—19 (56%), *in*—11 (32%). *Caeruleo-punctata*—16 (41%). Very

bright, the spots on the fore-wings are often small. The tail is just indicated.

Racial Brood. 99 examined. Critical Spot: *out*—21 (21%), *in*—65 (66%). *Caeruleo-punctata*—47 (47%). The males are often exceedingly suffused, the females less so. The tails are, I think, consistently longer in this island than anywhere else. The anal angle is elongated into a small projection, and a deep indentation between this and the true tail accentuates both.

Crete.

Racial Brood. Unfortunately I have only examined four from this island. Critical Spot: 2—*in*. *Caeruleo-punctata*—0. In these four specimens the tails are shorter than in the form from Cyprus, which they resemble closely in other respects.

12. The Southern Coast of the Mediterranean.

Tunisia.

Racial Brood. 20 examined. Critical Spot: 9—*out*, 7—*in*. *Caeruleo-punctata*—1. The specimens are considerably suffused and the copper which remains is very dull. The tails are long. I have only seen specimens from a few places near the coast.

Algeria.

I have examined a very large number of specimens from this country. In every case the Constant Broods are small, bright and typical in appearance, a tail is just indicated. The Racial Broods are larger; the copper is always dull, but, though suffusion is the rule, it is rarely extensive. The tails are long. The sexes are sufficiently distinct, but they present a marked contrast to the form from the eastern end of the Mediterranean, where they are widely dissimilar, while the extensive suffusion commonly found in males from Syria and Palestine could hardly be paralleled here. A magnificent aberration occurs not infrequently in this area. The spots of the distal series on the fore-wing are continued outwards in broad streaks until they meet the marginal band; the cell-spots are somewhat enlarged, and the whole insect more or less suffused (Plate LIV, fig. 19). I have seen more specimens of this form from Algeria than from the whole of the remainder of the Palaearctic Region.

Dividing the country into four districts I have calculated in each the percentage in which the Critical Spot is turned in and out, and of the *caeruleo-punctata* form, excluding certain localities from which I have seen unusually large numbers. These are dealt with separately.

(1) *The Province of Constantine.*

Constant Brood. 64 examined. Critical Spot: *out*—42 (66%), *in*—5 (8%). *Caeruleo-punctata*—23 (36%).

Racial Brood. 24 examined. Critical Spot: 10—*out*, 6—*in*. *Caeruleo-punctata*—0.

Batna (*considered separately*).

Constant Brood. 46 examined. Critical Spot: *out*—32 (70%), *in*—2 (4%). *Caeruleo-punctata*—8 (17%).

(2) *The Province of Algeria.*

Constant Brood. 33 examined. Critical Spot: *out*—24 (73%), *in*—4 (12%). *Caeruleo-punctata*—2 (6%).

Racial Brood. 50 examined. Critical Spot: *out*—24 (48%), *in*—18 (36%). *Caeruleo-punctata*—12 (24%).

Algiers (*town and immediate neighbourhood*).

Constant Brood. 28 examined. Critical Spot: *out*—14 (50%), *in*—2 (7%). *Caeruleo-punctata*—5 (18%).

Racial Brood. 50 examined. Critical Spot: *out*—18 (36%), *in*—30 (60%). *Caeruleo-punctata*—6 (12%).

(3) *Southern Algeria.*

Constant Brood. 28 examined. Critical Spot: *out*—8 (29%), *in*—6 (21%). *Caeruleo-punctata*—6 (21%). A very remarkable form recalling the Saharan specimens to be described later (p. 719). They are large and bright, while the hind-wings have, on the upperside, a distinct powdering of metallic scales within the copper band.

Racial Brood. Only 17 examined. Critical Spot: 8—*out*, 7—*in*. *Caeruleo-punctata*—5. These are dark and are more deeply suffused than most Algerian specimens. The tails are long.

(4) *The Province of Oran.*

Constant Brood. 40 examined. Critical Spot: *out*—29 (73%), *in*—2 (5%). *Caeruleo-punctata*—7 (18%).

Racial Brood. 42 examined. Critical Spot: *out*—19 (45%), *in*—15 (36%). *Caeruleo-punctata*—2 (5%). This brood is quite typical of Algeria, being very dull but not much suffused. The specimens are large and have long tails.

Aïn Sefra.

Constant Brood. 27 examined. Critical Spot: *out*—14 (52%), *in*—9 (33%). *Caeruleo-punctata*—4 (15%).
Racial Brood. 13 examined. Critical Spot: 5—*out*, 6—*in*. *Caeruleo-punctata*—4.

Sebdou.

Constant Brood. Only 3 examined. Critical Spot: 2—*out*, 1—*in*. *Caeruleo-punctata*—1.
Racial Brood. 50 examined. Critical Spot: *out*—18 (36%), *in*—24 (48%). *Caeruleo-punctata*—8 (16%).

Afiou.

Constant Brood. 45 examined. Critical Spot: *out*—36 (80%), *in*—4 (9%). *Caeruleo-punctata*—10 (22%).
Racial Brood. Only 13 examined. Critical Spot: 6—*out*, 6—*in*. *Caeruleo-punctata*—1.

Marocco (Eastern).

Constant Brood. Only 5 examined. Critical Spot: 4—*out*, none turned definitely *in*. *Caeruleo-punctata*—2. These are small, bright, typical insects.
Racial Brood. 30 specimens. Critical Spot: *out*—14 (47%), *in*—10 (33%). *Caeruleo-punctata*—3 (10%). The specimens are large and their tails are long. The copper is very dull, though there is little suffusion. The black border and spots on the fore-wings are usually large.

13. The Atlantic Coast (Tangier to Mogador).

Constant Brood. Only 16 examined. Critical Spot: 9—*out*, 3—*in*. *Caeruleo-punctata*—7. All are small, bright, and typical in appearance.
Racial Brood. 30 specimens. Critical Spot: *out*—19 (63%), *in*—10 (33%). *Caeruleo-punctata*—5 (17%). The specimens are large, with long tails. The copper is often remarkably dull, but suffusion is uncommon. In several examples which I have seen from Tamarouth it has a curious purple tint and is almost lustreless.

14. The Western Border of the Sahara.

El Biar (27° 35′ N., 9° 12′ W.).

I have seen four specimens from this place.* Two are of the Constant Brood and very typical in appearance. The others are much larger and approach more nearly to the Abyssinian form than any other Palaearctic specimens I have examined. They are quite unsuffused, and the copper inclines towards the brick-dust shade which is so noticeable in *pseudophlaeas*. The hind-wings are thickly dusted with copper scales up to the base, and the band within the outer margin is unusually broad. Indeed, on the upper surface, they would both pass quite well for Abyssinian specimens. Below the resemblance is not maintained, for they have no trace of the deep red-brown ground-colour to be seen on the hind-wings of Ethiopian forms.

From Casba (28° 10′ N., 8° 20′ W.) I have seen but one specimen; it is of little interest, being a Constant Brood and perfectly typical except that it is well above the average size.

15. The Canary Islands.

Here the species is not highly specialized. Considering the remarkable race occurring in Madeira, more striking modifications might well be expected in these islands. Nevertheless the form is not devoid of interest. In both types of brood the spots on the fore-wings, as well as the black margin, tend to become unusually developed; they generally remain definite in outline, and are not surrounded by a slight cloud of dark scales. The copper is wonderfully bright; the brilliance persisting in the Racial Broods even though suffusion—generally slight—may be present. The specimens are large and practically tailless. In the Racial Broods the underside of the hind-wings is a deep blackish brown.

Grand Canary.

Constant Brood. 14 specimens examined. Critical Spot: 12—*out*, 1—*in*. *Caeruleo-punctata*—6.

Racial Brood. 6 specimens examined. Critical Spot: 5—*out*, 1—*in*. *Caeruleo-punctata*—4.

* For a further account of these specimens see Proc. Ent. Soc. Lond., 1923, pp. xxiv–xxv.

Tenerife.

Constant Brood. 33 specimens examined. Critical Spot: *out*—27 (82%), *in*—5 (15%). *Caeruleo-punctata*—12 (36%).

Racial Brood. 20 specimens. Critical Spot: 14—*out*, 4—*in*. *Caeruleo-punctata*—12.

I find no difference between the specimens from these two islands.

16. Madeira.

Among all the races of *H. phlaeas* there is none more remarkable than that from Madeira, for it shows no special affinity with any known form. It was described by Staudinger as s.-sp. *phlaeoides*, a name over which a considerable amount of confusion has arisen. All authors agree that it is exclusively Madeiran, but there is an impression that it refers only to the specimens which are greatly suffused. Thus Seitz says:* "In the most western form, *phlaeoides* Stgr., from Madeira, the black colour of the hind-wings is so extended that the red submarginal band is hidden. But I found such melanotic specimens also on the Continent, the specimen figured as '*eleus*' and obtained by me near Lisbon is more extended black [*sic*] than all the specimens I caught at Funchal on Madeira."

Surprise has frequently been expressed that bright unsuffused specimens should appear in this locality, which is notable for producing a race having the fore-wings almost black. The matter is simple when viewed in the light of what has already been said. The unsuffused examples are the Constant Brood which "approximate to the typical form of the species" (p. 696) here as elsewhere, even though it retains one or two features which are characteristic of the island. It only appears in the late autumn and early spring, after which the heat is sufficient to react upon the pupa, and to produce the almost black Racial Brood. Even in specimens from the cooler part of the year the copper has acquired a singular tint, resembling that of a tarnished sovereign. But the latest autumn and earliest spring insects have been subjected to the least heat of all in the pupal stage, and these may be normally bright and fiery.

* "The Macrolepidoptera of the World," Section 1. The Palaearctic Region (translated by Dr. K. Jordan), vol. i, p. 286.

Phlaeoides was originally described from specimens captured on the hills behind Funchal thus :—

"Alis posterioribus subtus fascia antimarginali dilutiore (cinerea) distincta." *

It is unfortunate that this description is so condensed and that it omits several extremely interesting features of the race. It does, however, fix upon the most distinctive character of all, and one which occurs to a greater or less extent in 100% of the specimens from this island. The underside of the hind-wings is of a rich brown tint, somewhat mottled; at their base there are a few pale scales, and there is the faintest trace of a red line within the margin. The distinctive feature described by Staudinger consists of a broad, irregular, somewhat elbowed band, of a pale grey tint or even whitish, running beyond the distal row of black dots. It is developed in the brightest of the Constant Brood specimens as well as in the blackest of the Racial Broods, and forms the one true test of *phlaeoides*.

Taking the race as a whole, the specimens are never very large. The tail is quite rudimentary, even in the most suffused examples. In a very high percentage the Critical Spot is turned in. The black colour, whether developed on the hind-wings, in the spots or the marginal border of the fore-wings, or as a suffusion, is of a remarkably intense shade. Not infrequently extra spots appear between the Critical Spot and the base of the wing, a feature peculiarly Madeiran, and only known as one of the rarest aberrations elsewhere. The *caeruleo-punctata* form is not well developed in the island.

Constant Broods. 38 specimens. Critical Spot: *out*—6 (16%), *in*—31 (82%). *Caeruleo-punctata* (usually but little developed) 13 (34%). These insects are generally well below the average size. There is no tail. The copper when not bright, as in a few specimens emerging in the coolest part of the year, has the appearance of tarnished gold. The ground-colour of the underside of the hind-wings is somewhat greyish. (Plate LIV, figs. 1, 20.)

Racial Broods. 29 specimens. Critical Spot: *out*—0, *in*—29 (100%). *Caeruleo-punctata*—5 (17%). The specimens composing this brood are of moderate size with only rudimentary tails. The fore-wings are covered above with

* Staudinger's "Catalogue," 3rd edition (1901), p. 74.

a coal-black suffusion, though the few remaining copper scales are fiery in tint. (Plate LIV, fig. 8—not dark enough.)

Mr. G. T. Bethune-Baker has kindly given me the opportunity of examining his Madeiran specimens, which were captured by Wollaston more than seventy years ago. There is a slight but noticeable difference between these and recent examples. Nearly all the characters of *phlaeoides* are present, but they are less developed in the following particulars: The pale band on the underside of the hind-wings is less noticeable. None have extra spots developed between the Critical Spot and the base of the fore-wing, though this might well be expected among thirty-nine specimens. The blue spots are more pronounced in the *caeruleo-punctata* form. The Constant Brood examples (of which there are fourteen) are larger, and they lack the distinctive colour of tarnished gold, this being the most noticeable alteration of all. In the Racial Broods, to which twenty-five belong, the suffusion is less intense and the tails less reduced.

It is most interesting to find that the lapse of such a comparatively short space of time as seventy or eighty years should have effected an observable change in this form. It seems to suggest that *phlaeas* established itself in Madeira at no very remote period. The question arises, from whence did it come? The three most probable sources of supply are Portugal, the coast of Marocco and the Canary Islands. At first sight it is equally dissimilar from the races inhabiting all three; however, from the foregoing account, it will be seen that the Racial Broods in the two latter localities are but little suffused, being merely large and dull, while in Portugal they are exceedingly dark. To my mind this fact weighs strongly in favour of that country being the place of origin of *phlaeoides*—the blackest of all the western forms.

It should be mentioned that in the Natural History Museum, South Kensington, are two specimens of *phlaeoides* labelled "Palmas, Canary Islands." Since this form is so exclusively restricted to Madeira, and so dissimilar from that known to occur in the Canaries, it seems highly probable that an error has been made in the locality.

II. A General Account of the Asiatic Forms.

The Asiatic forms of *Heodes phlaeas* are, perhaps, more remarkable than any others. They fall into three groups

of which the first, from Persia, is curiously enough an extreme modification of that found on the Levant.

The second group is the most heterogeneous, and includes the forms from Afghanistan, Bokhara and the surrounding country. These may be greatly suffused, though such a condition is infrequent. The copper is yellow and has lost, to a great extent, even its metallic appearance. All the dark markings and spots on the upper surface are a pale brown. The specimens vary considerably in size, some being quite large. The underside is extraordinarily pale and of a yellowish tint, on which the black spots sometimes show up conspicuously. There is a narrow red line within the margin.

The third group forms a graduated series from the western end of the Celestial Mountains to Japan, where this butterfly reaches its most magnificent development. Specimens from various localities differ in size, in degree of suffusion, and in several other respects, but all are remarkable for possessing a red band within the outer margin of the hind-wing on the underside, and this is characteristic of the Far Eastern *H. phlaeas*. In the Tian-Shan district it is narrow, but in Japan it is broader and far more vivid than the corresponding band in *Chrysophanus dispar* Haw. The sexes are often markedly dimorphic, the female being larger, but much less suffused, than the male. The copper, or that part of it which remains, is always bright and fiery and the dark markings and spots are of a very intense black, thus presenting the greatest possible contrast to the specimens from Afghanistan. The tails are absent or extremely short.

Tutt has made a summary of the described Asiatic forms,* which are four in number, though several other aberrations have also received names. The localities in which these occur are by no means clearly defined, nor are the descriptions as full as could be wished. I will, however, quote his remarks on the first three of them before dealing with the Asiatic localities in greater detail. The fourth, *chinensis* Felder, will be considered later.

"*a.* var. *turanica* Rühl." . . . "An intermediate race between the typical form and var. *eleus*; the upperside only slightly darkened; the underside very pale. Tura (Rühl)."

* "A Natural History of the British Lepidoptera," vol. viii, pp. 349–350.

"*β*. var. *oxiana* Gr.-Gr." . . . "In the month of May *phlaeas* is found everywhere in the Pamirs, but not beyond 4,000 ft. In the month of August, the second generation is on the wing; this, however, cannot be referred to *eleus*, because, although 'supra nigricans,' it is not 'caudata.' Besides, as far as I recollect, it is a transition to the form of *phlaeas* from Bokhara, which I describe as *oxiana* Gr.-Gr.; and which differs from the type (1) by the very dark coloration of the wings of the males above; (2) by the very pale coloration of the whole under surface of the hind-wings. Kabadian in mid-May (Grum-Grshimailo)."

"*γ*. var. *comedarum* Grum.-Grsh., 'Rom. Mém.' iv, p. 365 (1890); Rühl, 'Pal. Gross-Schmett,' p. 747 (1896); Tutt, 'Brit. Butts.,' p. 154 (1896). The form which I have reported from the south-east of the Kounjout Mountains approaches the var. *oxiana* very closely. Unfortunately I have only a single female, on which it is difficult to establish a new variety. Its distinctive characters are: (1) the largest example of *phlaeas* in my collection is 31 mm., whilst the form which I here describe is 36 mm. (2) The coloration above is very pale. (3) The coloration of the underside is paler than in *oxiana*, all the spots are very large and particularly strongly developed on the hind-wings. In case this form should be found constant I propose to call it *comedarum*. Taken on Col Beïk, at 14,000 ft. elevation, in mid-July (Grum-Grshimailo)."

From the above description of *comedarum*, Tutt makes it perfectly plain that he names the form himself, yet here, and at another passage in the same work (p. 340) he attributes the name to Grum-Grshimailo.

17. Mesopotamia.

Unfortunately I have seen very few specimens from this country. The scarlet band on the underside of the hind-wings, so characteristic of Eastern Asia, first appears here. How far it is a constant feature I cannot say, but it is certainly present, though very narrow, in one or two specimens from Babylon. These are rather small and bright, with but little suffusion, though they were captured during the first week of June. It is rather singular to find this character in a locality which seems, in a measure, cut off from the area where it is a prominent feature.

18. Persia.

Racial Brood. 14 specimens examined. Critical Spot: 4—*out*, 7—*in*. *Caeruleo-punctata*—5. These are greatly

suffused with a dull brownish shade, so that in one or two males only slight copper reflections remain, and these are of a yellowish tint. The metallic band on the hind-wings is distinctly red. On the under surface these specimens do not resemble any Asiatic form, the hind-wings being unicolorous brown as in Southern-European examples. The tails are very long.

I have only seen a single specimen belonging to a Constant Brood. It is quite unsuffused and the Critical Spot is turned out. The under surface of the hind-wing has a red band, though its colour is very pale. The presence of this band in a form which is by no means typically Asiatic is most interesting, suggesting that the character is just beginning to appear, and it would be very desirable to ascertain the proportion of the individuals possessing it. Its appearance in two Mesopotamian specimens is equally suggestive (p. 724).

19. Afghanistan.

Racial Brood. 15 examined. Critical Spot: 3—*out*, 12—*in*. *Caeruleo-punctata*—9. The majority that I have seen from this country appear to be var. *comedarum*. They are often of a very large size; the upper surface is pale, for the copper is yellowish and the dark markings brown. The spots on the fore-wings are often extended as wedge-shaped, dark clouds towards the base of the wings. The underside of the hind-wings is also very pale, being somewhat yellow, with the black spots and lunules very conspicuous. Here the red band is persistent in all the specimens, though it is very narrow. In two examples similar in other respects the fore-wings are heavily suffused above, and one has long tails.

20. Tibet.

The form which occurs in this country is considered here because it seems to be more nearly related to that from Afghanistan than to any other Palaearctic Race. Naturally the material is very difficult to obtain, and I have seen only the specimens (15 in number) which were brought back by the Tibet expedition of 1904. Since all of them are alike, and are different from any other known form, they may be considered to constitute a local race which I propose to describe as s.-sp. *flavens*.

is pale grey, on which the black spots show up very distinctly. In nearly all specimens it is powdered with yellow scales which can always be seen if looked at from an angle, but are generally quite obvious. Within the outer margin is a broad band the colour of red lead. In the Racial Broods the Critical Spot is never turned out (in a very few its direction is doubtful, being hour-glass shaped) and blue spots are never developed; this at least was true in the forty-nine specimens examined from various parts of the country.

Constant Broods.—The specimens differ from the above description in that they are smaller, brighter, and unsuffused. The Critical Spot may turn in either direction, but most frequently outwards.

Constant Brood. 28 examined. Critical Spot: *out*—20 (71%), *in*—4 (14%). *Caeruleo-punctata*—0.

Racial Brood. 56 examined. Critical Spot: *out*—0, *in*—52 (93%). *Caeruleo-punctata*—0.

The species is widely distributed throughout the country and extends from Western China to the Chusan Islands. (Plate LIV, figs. 10, 11.)

23. Northern Manchuria and South-Eastern Siberia.

Little Khingan Mountains (immediately south of the Amur River).

Constant Brood. 2 specimens. Critical Spot: both *out*. These are small and typical in appearance. The underside of the hind-wings is pale grey with a very bright submarginal red line.

Racial Brood. 4 specimens. Critical Spot: 2—*out*, 1—*in*. These insects are larger. The underside of the hind-wings is a pale grey colour with a brilliant red submarginal band; there is a slight dusting of yellow scales over their entire surface.

Apfelgebirge (Transbaikalia).

Racial Brood? (June). 3 specimens. Critical Spot: 2—*out*, 1—divided. Bright and unsuffused above. The under surface of the hind-wings is grey, the black spots are very pronounced; the red submarginal line is narrower than in *chinensis*, though it is very bright.

The specimens from both the above localities are smaller than *chinensis*, from which they differ also in the broader

red band on the upperside of the hind-wings, and the narrower one below. The Critical Spot may be turned out in the Racial Brood; on the other hand none are of the *caeruleo-punctata* form. They provide, in the order given, most valuable links between the Eastern-Asiatic race and *hypophlaeas* (see pp. 735-738, 740-743).

24. Japan.

In this country *H. phlaeas* reaches its finest development. At first sight it appears to be the same form as that which occurs in China (i.e. *chinensis*). This, however, is not the case. Small but constant differences may be found, so that it would be an easy matter to separate correctly a number of unlabelled specimens from the two countries. This does not appear to be recognised. The Japanese form has been largely ignored or included in the race *chinensis*, to which it is closely related. Since it is a perfectly distinct local form it is well worth describing. I propose for it the name *japonica.*

Similar to *chinensis* in its general appearance but to be distinguished from that form by the following characters. Suffusion is much more frequent and extreme. In the Racial Broods the fore-wings of the males are frequently quite black: the sexes consequently are markedly dimorphic. The Critical Spot may be turned either out or in, and blue spots are not uncommon. The spots on the fore-wings are smaller. On the underside, the hind-wings are a much darker grey, so that the black spots are less obvious, the dusting of yellow scales which is usually such a noticeable feature in *chinensis* is entirely absent in *japonica*, while the scarlet band is slightly broader and, being on a darker ground, appears more brilliant. The type is in the Tring Zoological Museum.

These characteristics of the underside of the hind-wings hold good in Constant and Racial Broods alike, while in the latter the difference in the degree of suffusion, and in the Critical Spot, afford additional evidence that they are distinct. One form from Japan has already been named. This is ab. *daimio*, which Seitz introduces in the following words * :—" A gigantic form is found in Japan, but only in the summer and autumn, which, in addition to the large

* "The Macrolepidoptera of the World," Section 1. The Palaearctic Region (translated by Dr. K. Jordan), vol. i, p. 286.

prominent black markings and the red band on the underside of the hind-wing, may bear a row of bluish-white dots before the outer third of the upperside of the hind-wing. This form I caught myself in Japan, where I obtained it also from collectors under the name of ab. *daimio*, which may be accepted for it." This name appears, then, to be applied to *caeruleo-punctata* when it occurs in large dark specimens of the Racial Brood from Japan. It is the finest development to which *phlaeas* has attained. *Japonica*, on the other hand, includes all Japanese specimens, whether of a Constant or a Racial Brood. (Plate LIV, fig. 2 ♂, 9 ♀ ab. *daimio*, 16 ♀ underside, the type.)

Constant Brood. 78 examined. Critical Spot: *out*—64 (82%), *in*—4 (5%). *Caeruleo-punctata*—38 (49%).

Racial Brood. 97 examined. Critical Spot: *out*—18 (19%), *in*—60 (62%). *Caeruleo-punctata*—27 (28%).

The proportions have been calculated separately in an extensive series from two localities not included above:—

Yokohama.

Constant Brood. 28 examined. Critical Spot: *out*—22 (79%), *in*—2 (7%). *Caeruleo-punctata*—16 (57%).

Racial Brood. 32 examined. Critical Spot: *out*—8 (25%), *in*—18 (56%). *Caeruleo-punctata*—6 (19%).

Tokio.

Constant Brood. 26 examined. Critical Spot: *out*—24 (92%), *in*—1 (4%). *Caeruleo-punctata*—15 (58%).

Racial Brood. Only 8 examined. Critical Spot: 1—*out*, 6—*in*. *Caeruleo-punctata*—2.

25. Corea.

The form from Corea is curious, at least in the Racial Broods; the Constant Broods I have not seen. The specimens are exceedingly suffused but resemble *chinensis* except that the copper which remains, instead of being fiery, is yellowish and lustreless. On the under surface the hind-wings are in a condition intermediate between *chinensis* and *japonica*. Their ground-colour is a dark grey as in the latter, and they have a dusting of yellow scales as in the former. There is, of course, a scarlet band within the outer margin.

Gensen.

Racial Brood. Only fourteen examined. Critical Spot: 1—*out*, 11—*in*. No blue spots are present. It will be noticed that they further resemble *japonica* in that the Critical Spot is not always turned in.

III. Some Conclusions regarding the Palaearctic Races.

In the foregoing account of the variations of *Heodes phlaeas* in the Palaearctic Region, several points have arisen to which I desire to draw attention. A number of areas may be recognised in which the species varies in a definite way. In Northern Europe the broods differ but little from one another, so that almost all the specimens are small and bright. Along the north coast of the Mediterranean as far east as Italy the Racial Broods are very dark, for the copper is usually obscured by a glossy black suffusion, though, where it remains, it is bright and fiery. The tails are long. From hence to the Levant the specimens become progressively duller, and the copper yellower and less metallic in appearance. The tails become longer and the sexes more completely dimorphic. From Tunisia westwards suffusion becomes gradually a less prominent feature, and the tails are reduced. The Constant and Racial Broods remain, however, as distinct as before, owing to the dulness of the copper in the latter.

In Asia the forms are unstable as far east as Persia. A large pale race inhabits Afghanistan and the surrounding country, while from the Tian-Shan Mountains a magnificent form becomes progressively developed until it reaches Japan. This race is distinguished by possessing within the outer margin of the hind-wings below, a conspicuous red band which is characteristic of the Far Eastern forms of *H. phlaeas*. It is only occasionally indicated in European specimens and it may be slightly developed as an aberration elsewhere. I have seen one or two examples of a Constant Brood from Grand Canary in which this was the case. The length of the tail is generally correlated with the amount of suffusion: this is usually true of the European, but not of the Asiatic forms.

An examination of the Critical Spot leaves no doubt that it is turned outwards much more frequently in the Constant than in the Racial Broods, and inwards much more frequently in Racial than in Constant ones. I have

selected, from the foregoing data, eight localities from which large numbers of insects have been examined, in order to demonstrate this point.

Locality.	Critical Spot, out.		Critical Spot, in.	
	Constant Brood.	Racial Brood.	Constant Brood.	Racial Brood.
France (Mediterranean Coast)	63%	22%	16%	55%
Bihar Comitat (Hungary)	56%	25%	15%	45%
Cyprus	56%	21%	32%	66%
Algiers (Town)	50%	36%	7%	60%
Oran (Province)	73%	45%	5%	36%
Madeira	16%	0	82%	100%
China	71%	0	14%	93%
Japan	82%	19%	5%	62%

It will be seen that in no single case do the figures in the second column amount to as much as the corresponding ones in the first, and, conversely, that those in the third column never amount to as much as the corresponding ones in the fourth. Also that, in every column, the numbers are very nearly the same in three or four cases, but in one or two localities entirely different proportions appear, proving that the Critical Spot is a character which varies racially.

F. The Oriental Region.

1. *General Remarks.*

The Oriental Region does not include an important part of the range of *Heodes phlaeas*. The species only occurs in Northern India and never far south of the Himalayas. The insects are of moderate size; tails are well developed in one form (s.-sp. *timeus* Cramer, see pp. 733-734), otherwise they are absent or quite rudimentary. The underside of the hind-wings is grey or brown, generally with a yellowish tone; within the outer margin a red line is somewhat feebly developed. On the upper surface the fore-wings may be entirely black, but the copper when it remains is fiery. Nowhere else are specimens of this kind found with the type of underside described above, so that they are quite characteristic of India. More frequently there is

little or no suffusion. The Oriental origin of such examples is usually very obvious, for in them the copper is rarely bright but has a curious yellowish-grey tint, which is unmistakable. (Plate LIV. figs 15, 17.)

Deeply suffused Forms. 32 examined. Critical Spot: *out*—10 (31%), *in*—18 (56%). *Caeruleo-punctata*—20 (63%).

Unsuffused Forms. 36 examined. Critical Spot: *out*—32 (89%), *in*—4 (11%). *Caeruleo-punctata*—20 (56%).

Goorais Valley (*Kashmir*).

I have examined sixty specimens from this locality. There is a good deal of suffusion in some, but not of the most extreme character. The uppersides have generally rather a yellow appearance. Critical Spot: *out*—42 (70%), *in*—6 (10%). *Caeruleo-punctata* 34 (57%).

In the Oriental Region the division of broods into the Constant and Racial type is of little value, though these still appear with reduced differences. The temperature is sufficient, even in the coolest part of the year, to produce the characteristics of the Race. It will be seen from the above data that the *caeruleo-punctata* form is unusually frequent and it is often very highly developed. Suffusion seems largely to depend on the rainfall and consequent luxuriance of the vegetation.*

2. *The three named Forms.*

Three Indian forms have received names :—

(1) s.-sp. *timeus* Cramer, "Pap. Ex.," vol. 2, p. 137, pl. clxxxvi, figs. E, F (1777). "The red colour of the upperside of the wings, and the dirty yellow ground-colour on the underside of the fore-wings, are shining, exactly as that of *P. virgaureae* and *P. phlaeas*, there being much resemblance between the last named and that we figure. It belongs, like the others, to the 'Argus' group (*Papilio Plebeius Ruralus*). It was taken in Smyrna." †

Cramer was under the impression that this was a new species. It is curious that the name was first given to an aberration from Smyrna which becomes racial in India.

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* See de Nicéville, "Butterflies of India," vol. iii, p. 317.

† See Tutt, "A Natural History of the British Lepidoptera," vol. viii, p. 350.

De Nicéville ("Butts. of India," vol. iii, pp. 315–316) describes it in greater detail as follows :—

"♂ ♀, 1·3 ins.–1·7 ins. ♂, larger than the typical form; upperside of fore-wing very much darker, the coppery colour almost entirely overlaid with blackish; the black spots larger; otherwise as in the typical form. ♀, larger; upperside of fore-wing with the lower basal area thickly overlaid with blackish scales, having the apical and outer portions alone of the coppery ground-colour quite clear. Hind-wing with the discal blue spots often very large and prominent, otherwise as in the typical form."

(2) s.-sp. *stygianus* Butler, "Proc. Zool. Soc. Lond.," p. 408, pl. xxxix, fig. 5 (1880). "♂, smoky-brown; the primaries in certain lights shot with fiery copper; spotted with black as in *C. timeus* (? *eleus* Fabr.); two small orange spots beyond the interrupted black discal series; the hind-wings with a slender, undulated, deep, reddish-orange band on a black ground near the outer margin; above it a series of four or five pale blue hastate spots, and above these again, beyond the end of the cell, two black dots; a black dash at the end of the cell; fringes greyish white; body blackish. Wings below, very like *C. timeus*, but considerably paler, the submarginal black spots of primaries less distinctly white-bordered; the apex and outer margin of primaries, and the ground-colour of the secondaries, very pale grey. Expanse of wings 1 in. 4 lin. The ♀ larger than the ♂; the primaries, with the outer third of the cell, and the subapical area, bright orange; the black spots larger, otherwise similar; below slightly yellower in tint all over, so that the ground-colour of the secondaries has a pale brownish, rather than greyish, hue; expanse of wings, 1 in. 5 lin. Common in April and May, abundant in June. This insect is considerably larger than *C. phlaeas*, and has the costal margin of the primaries longer."

(3) s.-sp.? *baralacha* Moore, "Journ. As. Soc. Beng.," vol. liii, p. 25, pt. 2 (1884). "Expanse 1·37 ins. ♀. Differs from specimens of the same sex of *phlaeas* var. *stygianus* Butl., taken in the neighbouring country of Lahoul. Upperside of fore-wing golden yellow, with a blackish quadrate spot in the middle of the cell, a larger spot at its end; three oblique subapical spots, and three lower discal spots, the lowest spot being the longest and curved; from the three subapical spots some black freckles proceed to the discocellular spot; the costal edge is very narrowly bordered with brown, and the exterior margin has a narrow macular brown border of half the width of that of the above-mentioned species. Hind-wing golden greyish brown, with a broad, pale red, outer marginal band, which is very slightly indented with black at the end of the veins on its

outer border, and, on the inner border by a row of distinct blackish spots, and a black lunule at the end of the cell. The underside of similar colour to that of the above species; fore-wing with the spots as on the upperside, but pale bordered, also a spot at the base of the cell, two small spots on the costa above the distal series, and three linear spots on the exterior margin above the angle, these latter spots being near the margin, hind-wing with less defined, red-streaked marginal band, the discal and other spots also comparatively larger. Baralacha Pass, 16,060 ft., Ladak, taken July 1879, by de Nicéville."

De Nicéville ("Butts. of India," vol. iii, p. 317) remarks that "the type (and only known specimen) of this local race is in the Indian Museum, Calcutta. . . ." The wisdom of naming forms from a single specimen seems to me somewhat questionable. S.-sp.? *baralacha* may well be a local race, but I cannot see that we have any guarantee that this is so, or indeed that it is anything but a chance aberration.

G. The Nearctic Region.

1. *H. phlaeas hypophlaeas described; its Characteristics.*

Heodes phlaeas occurs throughout the greater part of the Nearctic Region, from Ellesmere Land in the north to California and Texas in the south. With one exception (s.-sp. *fieldeni* McLach., see pp. 738–739), the whole of this great area is inhabited by a single race, a condition unparalleled elsewhere in the range of the species. It has been known variously as *hypophlaeas* Bdv., "Ann. Soc. Ent. Fr.," 2nd series, vol. x, p. 291 (1852); *americanus* D'Urb., "Can. Nat.," vol. v, p. 246 (1860); and *americana* Harr., "Ins. Inj. Veg.," 3rd ed. pp. 273–274, fig. 104 (1862). The name *hypophlaeas* therefore stands as the oldest. Boisduval's description is as follows:—

"Très voisin de notre *phlaeas*, mais plus petit, avec les points plus marquées, les aîles plus arrondies; le dessous des aîles inférieures d'un cendré-blanchâtre, avec la bande fauve marginale bien marquée. Nord de la Californie. Il se retrouve dans tout le nord des Etats-Unis."

Little of importance can be added to this short but excellent summary of the characteristics of the Nearctic form. On the upperside *hypophlaeas* is very similar to certain small specimens of the Constant Brood from the

Palaearctic Region, save that the markings are perhaps even more definite, and the copper brighter. Only the smallest vestige of a tail is found, and that but seldom. The under surface of the hind-wings is truly remarkable. The paleness of the grey or brownish ground-colour causes the black spots and lunules to show up with great distinctness, but the most conspicuous feature is the bright red band within the outer margin. Occasional aberrations are as frequent in this race as they are elsewhere. It is to this that Tutt refers in the following passage: * "The North-American race of this species has been variously known as *hypophlaeas* and *americana*, and appears to be, on the whole, little less variable than the Palaearctic insect. No form so white as our ab. *alba*, usually, but erroneously, called *schmidtii*, has yet been taken there, but an approach to our ab. *intermedia* is found in the *fulliolus* of Hulst, while two of our best-known European forms, ab. *obliterata* and ab. *fasciata*, were first described from American specimens." An example of *hypophlaeas* ab. *alba* is figured on Plate LIV, fig. 13 (Tring Zoological Museum). The two European forms, to which Tutt alludes as being named from American specimens, were described originally as follows :—

(1) ab. *obliterata* Scudd., "Butts. New Engl.," vol. ii, p. 1001 (1889). "There is a partial and nearly complete obliteration of the extra-mesial spots of the front wing, both above and below."

(2) ab. *fasciata* Streck., "Cat. Amer. Macro-Lep.," p. 101 (1878). "In the row of spots in the middle of the outer half of the wing, each spot, though perfectly distinct from the others, is expanded a very little exteriorly, and very much interiorly; the spots beyond the cell joining that which borders the outer limits of the same; those in the median interspaces extending nearly or quite to the base of the interspaces, and that of the medio-submedian interspace is, in one instance, as long as broad, and in the other twice as long as broad, instead of being, as normally, half as long as broad. On the under surface, the wings have the normal pattern."

One aberration (*fulliolus* Hulst) seems to be restricted to *hypophlaeas*. It was described as follows :—

Hulst, "Ent. Amer.," vol. ii, p. 182 (1886). "*C. americanus* var. *fulliolus*, nov. var. A variety of this common species in which the

* "A Natural History of the British Lepidoptera," vol. viii, pp. 341–342.

coppery-red is replaced by an equally glowing somewhat sooty-yellow."

2. *Constant and Racial Broods: a Summary of the Race.*

The distinction between Constant and Racial Broods in the Nearctic Region is somewhat uncertain. The former are always of the type previously described, as are the latter in the great majority of cases. A certain amount of suffusion is sometimes present in the Racial Brood, but this is not correlated with any of the features usually associated with it elsewhere. The size is not increased and the copper which remains is bright and metallic, while tails are never developed beyond the merest vestige. The underside of the hind-wings is occasionally of a darkish brown, so that the black spots are less obvious. The red band within the outer margin is usually present, but in exceptional instances even this may almost be lost.

Owing to the uniformity of American specimens and the difficulty of determining to which type of brood undated examples belong, I have calculated the percentage in which the Critical Spot is turned out and in and of the *caeruleo-punctata* form for all the Nearctic specimens examined in detail. An exception has, however, been made in favour of a series from Montreal in Mr. G. T. Bethune-Baker's collection, which shows the characteristics of the Racial Brood in a most remarkable degree, and is therefore considered separately.

Canada and the United States.

85 examined. Critical Spot: *out*—34 (40%), *in*—29 (34%). *Caeruleo-punctata*—19 (22%).

Montreal.

Constant Brood. 2 specimens examined. Critical Spot: 1—*out*, 1—*in*. *Caeruleo-punctata*—0.

Racial Brood. 8 specimens. Critical Spot: 3—*out*, 4—*in*. *Caeruleo-punctata*—1. In these the underside of the hind-wing is brown, and in one or two the red band is almost absent.

There has been, in the past, a considerable amount of controversy as to whether *hypophlaeas* is, or is not, a species distinct from *phlaeas*. The late Dr. Chapman's report on their genitalia (see p. 704) affords adequate proof that the

two are specifically identical. It may be mentioned, in addition, that the two forms show the closest similarity throughout their life-history, that there are races more or less intermediate between them (see pp. 728–729), and that *hypophlaeas* is also found in the extreme north of the Palaearctic Region.

H. The Circumpolar Forms.

Two forms of *Heodes phlaeas* occurring in the Far North have been described.

(1) *Hypophlaeas* Bdv. This has been dealt with in the preceeding section. Not only does it occur throughout the Nearctic Region, but it has an extended range in Arctic Europe and Asia. There is a specimen from Siberia in the Hill Museum, Witley, and two from Amurland in the Natural History Museum, South Kensington, while Staudinger also refers to specimens from the latter country. There can be little doubt that this form will ultimately be found distributed along the north coast of Asiatic and European Russia, for it is known to occur in Lapland; there is a specimen from this locality in the Tring Zoological Museum (Plate LIV, fig. 21), another in the Hill Museum, together with one labelled "Norway," which, though it has no other data, must almost certainly have come from the extreme north-east of that country. For the numerous examples labelled *hypophlaeas* in collections from Norway, see p. 739–740.

(2) s.-sp. *fieldeni* McLachlan. "Journ. Linn. Soc.," vol. xiv, p. 111 (1878). "28 mm.–29 mm.; differs from typical *phlaeas* (and also from *americanus*) in the brilliant copper colour of the anterior wings being much less fiery and more subdued and with brassy reflections (especially in the ♂), so that the colour might almost be termed brassy rather than coppery; the spots normal in number and position, but smaller; the dark border narrow and silky greyish-black with grey fringe, the dark costal margin scarcely indicated; on the posterior wings the ground-colour is of the same silky greyish black as in the border of the anterior, the pale submarginal band pale orange, with occasionally the faintest indication of bluish spots upon it. Beneath the anterior wings are greyish orange (with the ordinary spots), the border and the posterior wings pale cinereous; on the latter wings, the dark dots are very faintly indicated, and there is also only the faintest indication of the red submarginal band. Three examples (two ♂, one ♀) from lat. 81° 45′."

These three insects, now in the Natural History Museum, are among the most interesting butterflies in the world, since they were captured (with four other species) in Grinnell Land, at the highest latitude at which Rhopalocera have so far been obtained—more than halfway to the Pole from the Arctic Circle. The Critical Spot is turned inwards in all three.

There is, in addition to these, a third Arctic form, which, though it is perfectly distinct in appearance and, I believe, in origin, and though specimens of it are not infrequent in collections, has never been separated from *hypophlaeas.* I propose to describe it as the race *hyperborea.*

Noticeably larger than *hypophlaeas.* The length of one fore-wing varies from 13·5–14 mm., while in the latter form the average seems to be from 12·5–13 mm. Above, the copper is somewhat brassy. The underside of the hind-wing is a beautiful blue grey, somewhat mottled, on which the black spots and lunules stand out very distinctly. It makes a striking contrast to the pale grey, brown, or drab colour of these wings in *hypophlaeas.* There is only an indication of the red submarginal line, but the trace of it is rather more obvious than in European specimens, owing to the very pale ground on which it is set. This evanescent line itself is distinctly dark and brownish, and could never be mistaken for the scarlet submarginal band of the Nearctic form.

Habitat: Arctic Norway and Lapland. It is not found in Siberia or North America. The type specimen (Plate LIV, fig. 14) is in the Hope Department of the University Museum, Oxford. It was captured at Alten, August 1906, by the late Mr. H. Rowland-Brown.

Twelve examples. The Critical Spot: 4—*out*, 6—*in*. *Caeruleo-punctata*—4.

Specimens of *hyperborea* are far more frequent in collections than are Palaearctic examples of *hypophlaeas.* Owing to the presence of this unrecognised form, some confusion exists in the literature dealing with the Far Northern races of *phlaeas.* For example Tutt remarks: * "He [Sparre-Schneider] thinks that *R. phlaeas* reaches its finest and largest development in the northern areas of its distribution, *e. g.*, the largest ♂ from Tromsö measured 28 mm., an expanse greater than that of his examples from Central and Southern Europe." On the other hand,

* "A Natural History of the British Lepidoptera," vol. viii, p. 342.

Boisduval's original description of *hypophlaeas* commences with the words, "Très voisin de notre *phlaeas*, mais plus petit . . .," and anyone acquainted with the Nearctic form of the species will agree with him. Sparre-Schneider was, of course, perfectly correct in his observations, but, writing in the Tromsö Mus. Aarsheft., vol. xv, p. 20, he was referring to *hyperborea*.

These two forms are represented on Plate LIV, so that they can be compared. Figs. 6, 14 (an upperside and underside, being a co-type and the type) represent *hyperborea* from Norway. Fig. 21 (an underside) represents *hypophlaeas* from "Lapland" (probably the country to the west of the White Sea), and figs. 5, 12 (an upperside and underside) *hypophlaeas* from the Nearctic Region.

I. The Origin of Heodes phlaeas hypophlaeas.

It is sufficiently obvious, from geographical considerations, that *H. phlaeas* must have populated the Nearctic Region from Asia. The distance by sea from North-Eastern Siberia to Alaska, by way of the "stepping-stones" of the Aleutian Islands, is very short compared with the great stretches of water which separate Europe from North America. The fact that no single species of butterfly has succeeded in establishing itself in Iceland * shows clearly enough the difficulty of crossing the North Atlantic. On the other hand, the high latitude of the Bering Sea could be no obstacle to a species which can maintain itself in Grinnell Land (see pp. 738–739).

A certain amount of evidence on this point may, however, be obtained from the specimens themselves. The forms of *phlaeas* inhabiting Eastern Asia differ in many respects, but they have one feature which is absolutely characteristic, viz. the scarlet submarginal band on the underside of the hind-wings. As migrations took place northwards, the insects which established themselves near the Amur River and in Southern and, finally, Northern Siberia, became affected by the lower temperature. They were reduced in size, and the feature most characteristic of warmth—suffusion—disappeared. The result was the production of a small bright butterfly, displaying local variation in the drab colour of the underside of its hind-wings, but retaining

* See Commander J. J. Walker, "Ent. Mo. Mag," vol. lviii, pp. 1–7 (1922).

the scarlet submarginal band characteristic of the district from which it came—in fact, *hypophlaeas*. The stages in this change may be studied to-day in specimens from the extreme north of Manchuria and the south of Siberia (pp. 728–729). There is reason to suppose that these *hypophlaeas*, populating North-Eastern Siberia, and resulting from a migration northwards from Eastern China, spread in two directions. These will be considered separately.

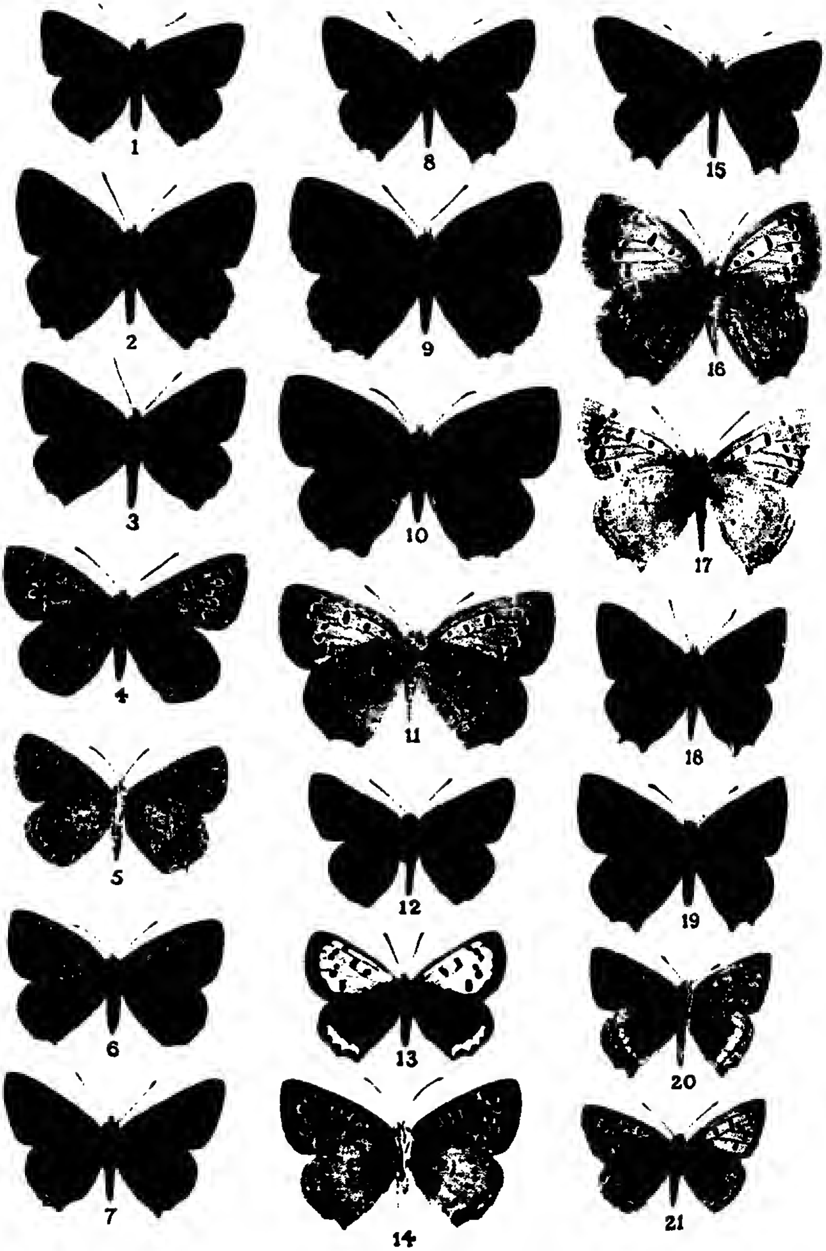
1. Westwards through Arctic Siberia and Russia to Lapland and the extreme north-east of Norway. In the two latter districts it meets the race which inhabits Northern Scandinavia—*hyperborea*. This differs from *hypophlaeas* in one or two important particulars. It is an improbable hypothesis to suggest that the latter race has, in this area, lost the red submarginal band on the lower surface of the hind-wings, and has become modified in other directions, when there is no climatic alteration to account for these differences. The same arguments apply to the reverse change, *hyperborea* to *hypophlaeas*, but with added force, since nothing could be more unlikely, from what we know of the species, that the character typical of Eastern Asia should arise separately in Lapland. Neither does it seem reasonable to believe that *H. phlaeas* has only made a successful migration into the arctic from the coast of China. Central Siberia might prove an obstacle to invasions from the south, so that specimens, having gained the north coast by way of Amurland and the east, could spread westwards undisturbed. Certainly, however, Norway and the Baltic Coasts present no such difficulties. All these facts point in one direction. That *hyperborea* and *hypophlaeas* are distinct in origin; the former being European, and connected with more southern latitudes by intermediate forms (see p. 710); the latter Eastern Asiatic, and retaining the stamp of that area. Their superficial resemblance is probably due to convergence, both having been modified by arctic conditions.

2. But a second migration seems to have taken place from North-Eastern Siberia. This has been eastwards across the Bering Sea, probably by way of the Aleutian Islands, into Alaska, thence populating North America. Hence in the north of the Nearctic Region we find a form displaying the chief characteristics of the Chinese *phlaeas* modified by arctic conditions. But as it spreads southwards heat begins once more to affect it, so that, in the

Racial Broods, suffusion may appear and the lower surface of the hind-wings may sometimes become dark brownish in colour. The Constant Broods are subjected to conditions less likely to alter their appearance, so that they remain of the true *hypophlaeas* type and are, in this sense, more primitive.

It has been pointed out previously that the species does not vary racially in the greater part of North America, and that even specimens from such southern localities as California and Texas are typical of *hypophlaeas* at least in the Constant Broods; they are, in fact, arctic in character. These two facts are very remarkable, especially so when we remember that *H. phlaeas* has so great a capacity for forming local races and, in the remainder of its range, that it varies from place to place in a most surprising manner. In my opinion they admit of but one explanation—that the species has populated America at a recent date, and that it has not had sufficient time to lose its arctic features or to form local races. We see, as it were, the first beginnings of a new form in a few Racial-Brood specimens. There is, however, one exception, viz. the s.-sp. *fieldeni* McLach., which may be regarded as an insect in which all other characters have been subordinated to those called forth by its Far Northern environment. Though it must necessarily have been derived from *hypophlaeas*, the red submarginal band on the under surface of the hind-wings is lost, so that its Asiatic origin is no longer apparent. It is not, I think, unreasonable to suppose that the unparalleled conditions existing at the highest latitude to which butterfly life can extend, should effect a radical change in the appearance of the insect in a space of time insufficient to produce any regular change, even in the broods subjected to the summer warmth of California.

The above hypothesis assumes that the red submarginal band on the under surface of the hind-wings is more stable in character than are the other local changes in the appearance of *Heodes phlaeas*. It may well be asked if there is any evidence for such a conclusion. I think there is. Early in this memoir (p. 696) the Racial Broods were defined as those which "are produced at a time when the high temperature and peculiar climatic conditions of a given locality can most readily act upon the species and produce their characteristic effects." In every locality in the Palaearctic Region which has been studied in the foregoing



FORMS OF HEODES PHLAEAS.

pages, peculiar local races have been seen to develop in the Racial Broods, only to be replaced once more by the typical form in the Constant ones. Only two exceptions to this rule come to my mind—the underside of the hind-wing of the s.-sp. *phlaeoides* remains unaltered in the Constant Broods, and so does the red submarginal band of the Eastern Asiatic races. In China and Japan Constant and Racial Broods are well marked. The latter are large and suffused, characters which are lost in the Constant Broods; they differ also in the Critical Spot. The red band alone remains unchanged, affording one of the very few instances in which a racial feature possesses sufficient stability to withstand marked alterations of temperature. If the conclusion be sound that the Nearctic forms of *H. phlaeas* were derived from the Eastern Asiatic race, then the stability of this feature in the New World is only what we should expect, seeing that it is the very same character which has been shown to be especially stable in the Old.

Description of Plate LIV.

Heodes phlaeas L.

Fig. 1. Madeira (s.-sp. *phlaeoides* Stgr.), Constant Brood.
2. Japan ♂ (*japonica* n.s.-sp.), Racial Brood.
3. Tian-Shan (*coccineus* n.s.-sp.).
4. ,, ,, ,, underside.
5. North America (s.-sp. *hypophlaeas* Bdv.), underside.
6. Norway (*hyperborea* n.s.-sp.).
7. Berlin (ab. *schmidtii* Gerh. much suffused).
8. Madeira (s.-sp. *phlaeoides* Stgr.), Racial Brood. (In this figure the suffusion is not sufficiently pronounced.)
9. Japan ♀ (*japonica* n.s.-sp., ab. *daimio* Seitz), Racial Brood.
10. China ♀ (s.-sp. *chinensis* Felder), Racial Brood.
11. ,, ,, ,, ,, ,, underside.
12. North America (s.-sp. *hypophlaeas* Bdv.).
13. ,, ,, (s.-sp. *hypophlaeas* Bdv. ab. *alba* Tutt).
14. Norway (*hyperborea* n.s.-sp.), *type*, underside.
15. India.
16. Japan (*japonica* n.s.-sp.), *type*, underside; Racial Brood.
17. India, underside.
18. Asia Minor. S.E. coast. ♂ Racial Brood.
19. Algeria, Aïn Sefra. a recurrent aberration. Racial Brood.
20. Madeira (s.-sp. *phlaeoides* Stgr.), Constant Brood; underside.
21. Lapland (s.-sp. *hypophlaeas* Bdv.), underside.

April 15th, 1924.

THE

PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY

OF

LONDON

FOR THE YEAR 1923.

Wednesday, February 7th, 1923.

Mr. E. E. GREEN, F.Z.S., President, in the Chair.

Nomination of Vice-Presidents.

The PRESIDENT announced that he had nominated Mr. J. E. COLLIN, Professor E. B. POULTON, F.R.S., and Lord ROTHSCHILD, F.R.S., as Vice-Presidents for the ensuing year.

Election of Fellows.

The following were elected Fellows of the Society:—

Mr. G. D. MILLWARD, 32, Moorgate, E.C. 2; Mr. HAROLD WILKINSON, P.O. Box 93, Kampala, Uganda; Mr. J. D. DEAN, 20, St. Fagan's Road, Ely, Cardiff.

Exhibitions.

DANAIS CHRYSIPPUS L., FROM UPPER EGYPT.—Capt. K. J. HAYWARD exhibited a series of *D. chrysippus* L., collected or bred in the neighbourhood of Aswan, Upper Egypt, between September 1919 and March 1922 (with a few specimens from other localities).

It included both sexes of the form typical in that region,

this being the only one obtainable from April till November. After November the tendency is for the dark brown costal colouring to spread over the forewing, often 50 per cent. of a brood being thus coloured. The extreme is reached between mid December and mid January, when the whole of the upperside is sometimes dark brown, and the abdomen either very dark brown or black. For this the varietal name *axantha* has been proposed (*Entomologist*, LV, p. 178).

In var. *candidata* Hayw. (*loc. cit.*) the specimens are very thinly scaled and the scales slightly curled. In all, four such specimens are recorded from the district. One in November 1913, the two exhibited, and a third in January 1922. The two exhibited had red eyes.

A form with some white scaling on the hind-wing—rather uncommon except in the brood that produced the two *candidata* (*alcippoides* Moore).

He also exhibited the nearest approach to *alcippus* F. (and the only one approaching it) obtained from over 6000 bred and some 4000 specimens examined, though this form is locally common in other parts of Egypt, and various abnormal and aberrant individuals, including two specimens in which some brown colouring occurs on the black apical area.

The food-plant was found to be *Calotropis procera*, and larvae were tried on practically every other local plant without success. One specimen made one meal off geranium but would not continue feeding on it. No eggs were obtained in captivity. The pupae are normally green of the same shade as the leaf of the food-plant and suspended below it; if attached to the plant stalk or to a dead leaf, they are of a greyish-brown colour, and in both cases are highly procryptic. In experiments to see to what extent the pupae could adapt themselves to their surroundings, where the inside of breeding cage was plain pitch pine, the pupae made a very good match, being of a pinkish-brown, only ½ per cent. of them being the normal green. In a cage lined with papers of various colours and containing 1000 larvae, when the small unpapered portion of the cage was full, the larvae hanging up on the green pupated green. Those compelled to pupate on the bright colours pupated green.

The hour of emergence varied greatly on similar days; on three successive February days with equal climatic and temperature conditions for the 24 hours they emerged at 12 noon, 10.30 a.m. and 12.30 p.m., but generally speaking emergence took place about 8.30 a.m. in summer to 12.30 in winter.

The only parasite bred from *Danais chrysippus* was *Chalcis brevicornis*, whole broods being sometimes affected.

Capt. Hayward also exhibited a melanic aberration of *Polygonia c-album* L., taken at Bruton in Somerset.

Prof. Poulton congratulated Capt. Hayward on the extremely interesting results he had obtained, expressing surprise at the entire absence, among such very large numbers, of the *dorippus* (*klugii*), and full *alcippus* forms and the rarity of *alcippoides*. Higher up the Nile, and in the Nuba Mountains these forms were relatively abundant, while in Somaliland *dorippus* was even more predominant than the type form at Aswan. The interesting variety captured by Mr. G. H. Bullock in Fernando Po and exhibited by Dr. H. Eltringham in 1916 (Proceedings, 1916, p. xciii) seemed to be the same as the two shown by Capt. Hayward—viz. an albino as regards the orange-brown pigment. Dr. Eltringham described the butterfly as a form of *alcippus*, but there was no reason for considering it to belong to this rather than the type form, except the fact that *alcippus* was the commoner in Fernando Po—14 to 3 of the type and a single intermediate being recorded in Proc. Ent. Soc., 1916, p. ix. It was, of course, almost certain that Capt. Hayward's examples and the two others which he saw were varieties of the type form.

Acanthomyops (Donisthorpea) brunneus Latr., an Ant new to the British list.—Mr. Donisthorpe exhibited living examples and mounted specimens of the above ant, together with a piece of wood from the poplar tree inhabited by it. He said that a strong colony had been discovered by Dr. N. H. Joy in a felled poplar at Theale in January, and as the ant was unknown to him, he had sent specimens up to the exhibitor, who had at once recognised it as *A.* (*D.*) *brunneus*, a species new to Britain. Mr. Donisthorpe referred to the habits of this ant and its distribution, etc., and said

he had been down on the previous day to examine the colony in company with Dr. Joy, and had taken a few of the workers to form an observation colony.

A Pierine from Viti Levu, Fiji.—Dr. F. A. Dixey exhibited a male Pierine captured by Mr. H. W. Simmonds on October 25, 1922, and remarked on it as follows:—"In 1852 Lucas described under the name of *Pieris jacquinotii* a Pierine of the *Appias* group which was captured by M. Jacquinot of the *Astrolabe* at 'Balaou, New Guinea.' I have searched the 'Voyage le l'Astrolabe' in vain for the name of any such place as 'Balaou,' and can only suppose that what is meant is the Pelew Archipelago, between New Guinea and the Philippines, which islands were visited by the *Astrolabe* on her way from New Guinea to Amboyna. They are known to Spanish geographers as the 'Palaos.' A female, also from 'Balaou,' was described at the same time by Lucas as *P. athama*. From the analogy of other *Appias* forms there can, I think, be little doubt that *jacquinotii* and *athama* are male and female of the same species. But Mr. A. G. Butler subsequently identified some females from Samoa with Lucas's *P. athama*, and accordingly named one of the accompanying males from Samoa as the male type of *athama*. Wallace had figured what he supposed to be Lucas's female as *Tachyris athama*; but Butler considered Wallace's insect to belong rather to another form from the New Hebrides and New Caledonia, named by Butler *Appias* or *Catophaga wallacei*.

"There is, I think, little to distinguish these island forms from one another. It is true that all the females of *wallacei* in the British Museum, including the type, are yellow; but Lucas's *athama* is also described as 'blanc jaunâtre.' The males, whether from the New Hebrides, New Caledonia, or Samoa, appear to be barely distinguishable from each other and from the present specimen from Fiji. They may all, I think, be ranked under Lucas's name of *jacquinotii*, of which his *athama*, as we have seen, is probably the female.

"So far as I am aware, no other Fijian specimen is known. It was taken in the Sigatoka (Singatoka) Valley, towards the west end of south-west Viti Levu; a locality spoken of

by Mr. Simmonds as 'a good collecting ground between the wet and dry areas.' He saw several, but only took this one.

"As to the subdivisions of the genus *Appias*, which there is now a tendency to ignore, I am disposed to think that they represent realities, and so are in many respects convenient. I am therefore content to include the species which group themselves around *paulina* Cram., *ega* Boisd., and this Pacific island form, under the generic or subgeneric name *Catophaga*."

NOTE ON THE SCENT OF EUCHLOE AUSONIA f. EGYPTIACA VERITY.—Dr. F. A. DIXEY also exhibited specimens of the *egyptiaca* form of *E. ausonia* captured by Lt.-Col. R. S. Wilson in the Western Desert Province of Egypt, near the sea-coast, in March and April 1919. A male specimen caught on March 25 was noted as having a "faint sweetish scent after death." This appears to be the first notice of a scent in this species.

A BRITISH GEOMETRID.—Dr. K. JORDAN exhibited some specimens of Geometrids and said that the insect known as *Anaitis plagiata* L. (1758) consists of two species. In the true *A. plagiata* the claspers of the ♂ are very long, narrow, tapering, and are forked at the tip, ending with two sharp thorn-like teeth, and the last external (7th) abdominal segment of the ♀ is long. This species occurs in a larger spring form (first brood) and a smaller summer form (second brood), and is known to us from England to the south of France and eastward to Syria, Kashmir and Central Asia. The second species is about as large as the summer form of *A. plagiata*, but differs in the ♂-claspers being short and broad, and ventrally deeply sinuate beyond the middle, the clasper ending with a broad, somewhat spatulate, lobe; in the ♀ the seventh (last external) abdominal segment is shorter than in *A. plagiata* ♀, and the genital armature is likewise different. On the whole this second species is the paler of the two, but there does not seem to be any constant distinction in colour and pattern. As Guenée says of his *A. efformata* (1857), described from Syria, that it is smaller and paler than *A. plagiata*, that name may possibly apply to

our second species. This smaller species is evidently the only one south of the Mediterranean and in Southern Spain and Portugal, whence we have a large series of specimens, but in England, France, Switzerland, Italy, Hungary, Greece, and probably other European countries, both species are found. Our nine specimens from Cyprus and the one Syrian example we have belong to *A. plagiata*. The small specimens figured by Culot and Barrett as *plagiata* belong to the second species.

An Argynnis from California.—Mr. H. J. Turner exhibited a short series of *Argynnis atossa* Edw., from the Sierra Madre mountains of South California, where it had been taken in some numbers during the summer of 1922. Hitherto it had been considered very rare and had only been met with very sparingly on one or two occasions. It is a very distinct form, the underside of the hind-wings being of a uniform colour absolutely devoid of any markings. It is possibly nearest related to *A. adiante*. *A. leto* Berh., *A. nokomis* Edw., and *A. nevadensis* were also shown to illustrate the diverse coloration of the undersides of the hind-wings in this genus.

A small dragonfly captured sixty miles from land.—Prof. Poulton exhibited a male dragonfly captured by Major J. C. Moulton, at midnight, October 21, 1922, flying round the light in his cabin on board the P. and O. steamer *Karmala*. The ship was, at the time, sixty miles west of Colombo. This small and delicate insect had been kindly identified by Mr. H. Campion as *Aciagrion occidentale* Laidlaw, originally described from Bombay and Cochin State under the name *A. hisopa* Selys, race *occidentale*. The determination whether *occidentale* be a race or a distinct species was a subject for future inquiry. There was no doubt, however, that it occurred in Ceylon, and it was highly probable that the exhibited specimen came from this island.

Colour-adjustment in the wild pupae of Pieris rapae L.—Prof. Poulton exhibited twenty-one pupae of *rapae* collected by Mr. A. H. Hamm, October 14, 1922, on the Shotover Road near Oxford. Of these, eight were scattered over the upper part of a wall coloured by a pale grey wash

and without coping, while thirteen were all fixed horizontally along the topmost cement course of a red brick wall, immediately below a strongly projecting coping, and therefore in shade. The two sets were very similar, the latter being on the whole a little darker, as was to be expected from the tint of the cement and the closely adjacent brick, of a colour which has been shown to produce dark pupae.

It was probable that the colour-adjustment was not affected by the shadow under the coping. Other observations and experiments had also suggested that the stimulus which leads to colour-adjustment was due to the quality and not the quantity of light. If it were otherwise, various accidental circumstances, such as cloudy weather during the sensitive period, would seriously interfere with a procryptic effect lasting in many species over several months. The important necessity for the species was that the pupa should match its surroundings whatever the strength or weakness of the illumination during the critical period. When the two match each other, subsequent changes of illumination, affecting both equally, would not diminish the procrypsis.

Further Observations in 1922 on the Protective Resemblance of Polygonia c-album L., and the attacks of enemies on British butterflies.—Prof. Poulton exhibited an example of the early brood of *c-album* taken July 21, at Cothill, near Oxford, by Mr. A. H. Hamm, and of the late brood captured September 8, at Tubney, near Oxford, by Commander J. J. Walker. Both specimens had been set by Mr. Hamm so as to illustrate his repeated observation that, in the position of rest, the fore and hind wings were more widely separated in the later brood, causing a deeper, wider gap. The specimens also showed that the edges of both wings were more markedly out-turned and the projections more strongly marked in the same brood. Comparing several examples of the early brood with a long series of the later, the difference in the length of the main cusps and in the degree of development of the minor projections was obvious. Furthermore, the far blacker marginal bands on the upper surface of the later brood permitted the wing-edges to be more widely out-turned without detri-

ment to the procryptic effect (Proc. Ent. Soc. Lond., 1922, p. xxi).

The differences described above emphasised the resemblance to a tattered, weather-beaten piece of dead leaf in the brood which provided the hybernating butterflies. The attacks of birds on the early brood were illustrated by a specimen with both hind-wings symmetrically shorn, taken by Mr. Hamm at the same time and place as the butterfly shown at rest; attacks on the later brood by a similarly shorn butterfly captured on an aster in the Museum grounds on October 16, by Commander Walker. An example of *Limenitis sibylla* L., taken at Hurst Hill in the New Forest, June 29, by the same naturalist, was extensively shorn symmetrically through both fore and hind wings. The three above-mentioned butterflies were almost certainly seized when at rest with wings closed. A male *Argynnis adippe* L., captured by Mr. Hamm on July 21 at Tubney, had, with equal probability, been seized when at rest with expanded wings, or in flight. Here the only injury was a large piece taken out of the right hind-wing. All these injuries were observed before capture and all the specimens were, in other respects, in good condition.

It was interesting to compare the above injuries with those inflicted on a female *Gonepteryx rhamni* L., found, October 14, by Mr. Hamm on the Shotover Road, Oxford. The butterfly was resting, about one foot from the ground, on rank herbage in front of a hedge. The costa and the fore-wing immediately behind it had been removed on both sides from the tip to a distance of about half an inch. The injuries were not quite symmetrical and their form suggested that the butterfly had been disturbed and had shifted its wings a little during the attack. A glance at the exhibited specimen would at once show that the injury was not inflicted by a bird or lizard. The teeth of a mouse would have mangled the wings and could not have left the edge in its present condition—nearly smooth and cut into a curved, bay-like form along part of its length. The attacks of such predaceous insects as Carabidae or Tettigoniidae (Locustidae) were ruled out for the same reason, and the only probable interpretation

was the astonishing one that the apposed wings had been eaten from the edge by a caterpillar exactly as it eats a leaf. A careful examination with a lens of the cut edge supported this view, for it could then be seen that little pieces had been bitten out, with here and there a minute projecting point between two of them. The edge, which seemed at first sight so smooth, presented, in fact, precisely the appearance we should expect to be produced by the mandibles of a caterpillar. The apical quarter of the injured length was really smooth, and it seemed probable that this part broke away when the inner three-fourths had been eaten into, the caterpillar beginning at the portion nearest the wing-base and proceeding towards the tip. The breakage might have happened later on during the first flight after the injury, or, more probably, during its infliction, as one often saw a piece of leaf come away from the rest when a caterpillar was eating. It was probable that the wings of the resting butterfly happened to touch or come close to a leaf or stem reached by the caterpillar in its nocturnal wanderings. Such a larva as *Eupsilia satellitia* L., or *Cosmia trapezina* L.—but not these species because of the date—would probably be quite ready to sample the wings of a butterfly in these circumstances.

[Since the above conclusions were reached, my friend, Mr. F. C. Woodforde, has suggested the possibility that the injury was inflicted by an earwig. I do not remember the precise characters of earwig-attacks, although witnessed in former years only too often, but I think it unlikely that their traces would so completely resemble those of a caterpillar eating from the edge and inflicting no other damage of any kind.—Feb. 13, 1923. E. B. P.]

All-female families of Hypolimnas bolina L., bred in Fiji by H. W. Simmonds.—Prof. Poulton said that Mr. Simmonds had obtained astonishing results with this remarkable butterfly. It was hoped soon to publish a detailed account of his researches, with coloured figures of the different female forms, but in the meantime his discovery of all-female families in this species was so surprising that it was desirable to record the fact without delay. Out of

seven families reared from the eggs of known females and received by the Hope Department, no less than four were all-female, as shown by the following list:—

♀ Parent from island named.	Offspring.	
	Male.	Female.
♀ Y. 1921. Suva, Viti Levu	0	15 + 3
♀ Z. 1921. Suva, Viti Levu	0	4 + 1
♀ K. 1922. Ovalau	1 + ?	7 + 4
♀ X. 1921. Kandavu	3 + 10	11 + 5
♀ W. 1921. Kandavu	0	16
♀ S. 1921. Taviuni	9	12 + ? 1
♀ O. 1922. Dreketi River, Macuata Coast, N. Vanua Levu	0	20 + 6

The numbers added to the totals of the females are, except in the offspring of S., those of specimens retained by Mr. Simmonds, as explained in his letters. In addition to these he wrote on September 10, 1921.—" In the three biggest families I have retained the last few to emerge," so that the numbers of the females are really even more striking than would be inferred from the table. The " ? 1 " added to the females of S. refers to an evidently bred Taviuni specimen, with a consistent date, but not marked as belonging to this family. The families of parents Y., Z., W., and O. were each of them described in Mr. Simmond's letters as all-female, so that there is no question of the rejection or liberation of males. Furthermore, on September 10, 1921, he wrote:— " Of the four or five Suva families I have carried through from the egg I have only obtained females," thus showing that there were other such families as well as those here recorded. In addition to the twenty-six females in family O., Mr. Simmonds wrote that " unfortunately a few emerged while I was away at Sigatoka, so I have not seen all." With so many known to be female there can, of course, be no doubt about the sex of those which escaped.

As regards the males in the table on p. x there was little doubt that all were not retained in Family K. from Ovalau, while the 10 added to X. from Kandavu were recorded in one of the letters.

Mr. Simmonds considered that this marked tendency to produce all-female families in Suva strongly affected the proportions of the sexes in nature, for he stated in the letter of September 10, 1921 :—" There certainly are males here, but very few," and, on February 7, 1921, that at Levuka, in Ovalau, "the percentages of males must have been enormously higher" [than in Suva]. Of Tahiti (Society Islands) he wrote :—" There seem to be hundreds of males to one female. I say 'seem to be' because the two (now four) females I have taken are almost like the ♂, and, as all are worn, I may pass them by" (Proc. Ent. Soc. 1920, p. lxxii). This last inference was justified later on when Mr. Simmonds bred in Tahiti twenty-two males and twenty females from the mixed larvae of five female parents. And in Fiji, scattered larvae from Taviuni yielded ten males and seven females, from Vanua Mbalavu (Bavatu) two males and seven females, from Ovalau ten females. It was probable, however, that all the males had not been retained in these bred series from the two last islands. It will be of great interest to study the results of breeding on a large scale from scattered larvae in as many islands as possible, retaining, or at least carefully recording, the entire results in order to ascertain the precise effect of all-female families on the sex proportions. It is tempting to associate the mixed sexes of Family S. from Taviuni with the results given by scattered larvae from the same island, but larger numbers are required in order to reach trustworthy conclusions on this point.

In conducting such investigations it was important not to liberate butterflies in islands other than those from which their parents or larvae had been brought. To do so would tend to vitiate the results of future enquiries.

The prevalence of all-female families in other parts of the range of *bolina* is a most interesting subject for future investigation, as also the determination whether there are two strains of females, one producing only females, the other

mixed families, but neither of them parthenogenetic. The researches of Mr. W. A. Lamborn appeared to prove that such strains existed in *Acraea encedon* L., in the Lagos district of S. Nigeria (Proc. Ent. Soc., 1911, pp. liv–lvi; Linn. Soc. Journ. Zool., Vol. xxxii, Sept. 1914, p. 391).

Parent O., from Vanua Levu, was exhibited to the meeting, together with twenty of its female offspring, these latter providing a striking illustration of polymorphism, and throwing light on the origin of mimicry. But these subjects and any discussion of the laws of heredity which had been in operation were postponed to a future meeting.

Prof. POULTON was sure that the Fellows would warmly congratulate Mr. Simmonds on his most interesting discovery.

NOTES ON NEMOPTERIDS.—Mr. C. L. WITHYCOMBE, who illustrated his remarks with lantern slides, gave some account of three genera of Nemopterids and their larvae.

He mentioned that the larvae of all three genera of Crocini that he had examined were more or less long "necked," whereas the larva of *Nemoptera bipennis* Ill., had no distinct "neck." A photograph of this last larva was shown. It was seen to have a large, square head, with short, stout jaws, the head being sessile upon a very hirsute, oval body. All Nemopterid larvae examined possessed macrotrichia more or less in the form of dolichasters; these also occur to a greater or less extent in all Myrmeleonoid larvae.

A series of larval forms was thrown on the screen showing that the "neck" was composed of two lateral sclerites, well seen in *Ascalaphus*, which, by fusion above and below, formed a rigid "neck" in Crocini. These two sclerites might be regarded as cervical sclerites, but he gave reasons for preferring to regard them as prothoracic pleurites that had become displaced anteriorly.

Dr. A. D. Imms commented on the points raised and made some remarks on *Croce filiformis*.

Wednesday, March 7th, 1923.

Mr. E. E. Green, President, in the Chair.

The President announced that Dr. G. A. K. Marshall, C.M.G., had been nominated by the Council of the Royal Society for election as a Fellow, and a vote of congratulation was passed to him, with acclamation.

Election of Fellows.

The following were elected Fellows of the Society:—Mr. A. M. Stewart, 38, Ferguslie, Paisley, Renfrewshire, Scotland; Mr. F. G. S. Whitfield, 25, Drayton Gardens, S. Kensington, S.W.; Mr. A. J. C. Wightman, "Aurago," W. Chiltington Common, Pulborough, Sussex.

Exhibits.

Gynandromorphs of Lepidoptera.—Mr. G. Talbot exhibited on behalf of Mr. J. J. Joicey *Papilio ascalaphus* Bdv., from North Celebes, a specimen in which the female element is dominant. The right wing is entirely female; the left fore-wing with the grey male stripes present and nearly complete. The black ground colour of the male occurs in patches over the paler female colouring. The left hind-wing has the grey-blue male stripes well developed in cellules 2–4 and below 2; a trace of one in 5. The black male colouring spreads from the area occupied by the grey stripes and forms a narrow stripe through the cell to its base. On the underside of this wing the submarginal spots are female, and there is a trace of the white discal area. The abdomen has pale scales as in the female; orifice shaped as in female.

Zaretes isodora Cram., from French Guiana, the specimen being mostly female. The right wings are female, the hind-wing with a trace of male, more visible below. Left wings male with splashes of female colouring. Fore-legs: right legs female, left leg male.

Cyaniris argiolus L., locality ?. The male colouring predominates. Left wings male. Right fore-wing with the costa, apical area, outer margin and inner margin below

submedian female. Hind-wing with costal margin and distal half to vein 3 female; inner margin obliquely to vein 2 female. Fore-legs: right tarsus female, left tarsus male. Anal orifice as in female.

Lycaena icarus ab. *icarinus* Scriba, Genoa. Left side male, right side female, including the fore tarsi. Anal orifice apparently divided in the same way.

Celerio euphorbiae L., ? f. *dahli* Geyer, locality ?. Right side male, left side female. Frenulum female.

Samia cecropia L., locality ?. Right side male, left side female including antennae.

Colour Aberrations.

Agrias claudia f. *sahlkei* Honr., French Guiana. The normal red colouring is changed to a dirty yellow-brown. Band of the fore-wing paler below.

Heliconius doris L., French Guiana. The yellow spots of the fore-wing are dark green. Two males in the Joicey Coll.

Heliconius charithonia L., Honduras. A male specimen in which the bands and spots are white instead of yellow.

A VARIETY OF GRAMMESIA TRILINEA.—Major H. C. GUNTON exhibited a remarkable variety of *Grammesia trilinea* taken at Gerrard's Cross, Bucks.

FURTHER EVIDENCE THAT THE WINGS OF LEPIDOPTERA ARE SOMETIMES ATTACKED BY CATERPILLARS.—Prof POULTON, referring to the specimen of *Gonepteryx rhamni* exhibited at the last meeting (Proceedings, 1923, p. viii), communicated the following observation recorded by Mr. D. J. Gordon, of Balliol College, Oxford:—

"In the summer of 1918 a nearly full-fed larva of *Mamestra brassicae* was placed with a Geranium leaf in a glass-topped box which already contained a dead imago of *Tryphaena pronuba*. On looking at the box a few days later it was found that the larva had finished the leaf and attacked the wings of the dead moth. About one-third of the fore-wing on one side had been eaten and a piece from the other side, but I cannot remember whether the hind-wings were touched. What struck me most at the time was that the veins seemed

no obstacle, the larva having bitten straight across them when they came into the line along which it was eating. The wing had exactly the same appearance as a leaf attacked by a larva. Fresh Geranium leaves were given and the larva pupated, but I cannot remember whether it emerged."

This observation strongly supported the conclusion that the injury to the wings of *rhamni* was also caused by a caterpillar.

FRAGMENTS OF BEETLES FROM A PLEISTOCENE PEAT-BED AT WOLVERCOTE, NEAR OXFORD.—Prof. POULTON exhibited the specimens referred to in the following note by Capt. K. S. SANDFORD, B.A., F.G.S., of University College, Oxford, who was now preparing a complete account of the Bell collection. Elytra of apparently allied living species, all British except one, had been selected by Mr. J. Collins and were exhibited for comparison with the Pleistocene fragments.

"The specimens before the Society were collected by the late Mr. A. M. Bell, F.G.S., at some date before 1904, and came into the hands of the Department of Geology, University Museum, Oxford, on his death. They are probably only a part of those collected, as Bell expresses the opinion * that about thirty species were represented. It is possible that more may be found in other parts of the Bell collection, which was much split up at his death, only two sections of it having as yet come to light. It was in trying to trace the scattered collection last year that I found these specimens, which I at once submitted to Professor Poulton.

"The beetle remains occurred in a peaty band about two inches thick which had been deposited at the bottom of a running stream. The band has long since been worked out, but its relations to the present exposure can be determined. The peat covered about 2½ feet of sand and gravel, the general character of the vertebrate fauna of which indicates, in my opinion, a warm to temperate climate. A little higher, but below the peat, occur land and fluviatile mollusca which I believe indicate a temperate climate.

* A. M. Bell on "Implementiferous Sections at Wolvercote" (Q.J.G.S., vol. lx, 1904, p. 120).

"The peat itself carries a flora neither distinctively warm nor cold except the following two Alpine species :—*Hypnum capillifolium* (now only in Siberia and E. and N. Europe) and *Thuidium decipiens* De Not (now confined to Scottish Highlands). In addition to these the plant remains include seven species not now living in Oxfordshire.

"The youngest human culture identified in the sands and gravel is the Acheulean.

"The beetles would seem to be contemporary with Lower Palaeolithic man and, I believe, with a climate that was getting colder, not warmer.

"The flora was identified by the late Mr. Clement Reid."

The six specimens referred to by Capt. Sandford—all of them fragments of elytra except No. 6—were submitted to Mr. K. G. Blair, who had kindly examined them and written the following account :—

"1: elytron, nearly complete, of a *Donacia* sp. The sculpture most closely resembles that of *D. simplex* or *D. vulgaris* of existing British species, but the transverse sulci across the interstices are even more regular.

"2, 3 and 4: fragments of elytra showing more or less of the transverse basal carina receiving the striae of many carabidous genera. They are all probably referable to the genus *Amara*, but they differ so much in size that each must be assigned to a distinct species. None of these are positively recognisable as existing British species, but the specific recognition of fragments in a genus like *Amara* is not to be expected. In any case it cannot be asserted that they belong to species no longer existing in Britain.

"5: part of clytron probably referable to some large species of weevil. The sculpture is strongly pustulose, without very evident striae, recalling that of the lateral part of the elytra of *Liparus* (*Molytes*) *coronatus*. I have, however, not been able hitherto to match it exactly with any existing species. The under surface of this specimen exhibits a number of prominent pegs, indicating that we have now not the full original thickness of the clytron present, but either that the thin chitinous fragment represents only the upper surface of

an originally thick hard elytron, the rest, except the linings of the punctures, having disappeared; or that the thickness of the elytron has been very considerably compressed upon the upper surface, allowing the hard linings of the punctures to project on the underside.

"6: an irregular fragment of heavily punctured chitin not recognised.

"The material is therefore much too scanty to admit of any deductions being made as to climatic conditions at the time they were deposited. The presence of *Donacia* indicates marshy conditions such indeed as would be required for the accumulation of the peaty matrix. The same specimen and the weevil fragment are apparently referable to species no longer existing in Britain, and at any rate do not contradict the botanical evidence that the climate was colder than at the present day.

"In connection with this exhibit it may be remarked that similar beetle remains from Irish peat and from peat dredged up from the Dogger Bank,* both believed to be of post-Pleistocene origin, have yielded a good proportion of specimens assigned to present-day species, though in each case further specimens have so far defied determination. The Oxfordshire material is too scanty to justify comparison with these other finds, the only point in common to all being the presence of *Donacia*, while *Amara* has been identified also from the Dogger Bank. It is greatly to be desired that other material from the same source should be discovered in the hope of rendering such a comparison possible."

A Moth from Saint Helena in Britain.—Mr. J. H. Durrant exhibited an example of *Hieroxestis sanctae-helenae* Wollaston, taken at rest on the inside of a window of his house at Margate, 14. x. 1922, by Mr. H. G. Gomm, and suggested that it had possibly been introduced via the Canaries in bananas.

Dr. Malcolm Burr referred to the necessitous circumstances in Petrograd of A. P. Semenoff Tian-Shanski, an

* "Some Notes on 'Moorlog,'" by Whitehead and Goodchild, Essex Naturalist, vol. xvi. pp. 51–60; also "More about 'Moorlog,'" by H. Whitehead, *ibid.*, vol. xix. pp. 242–250.

Honorary Fellow of the Society, and said that remittances could be sent to him through the American Relief Fund, and a proposal by Mr. J. H. DURRANT, seconded by Mr. J. E. COLLIN, that the Society should head the list of subscribers with a donation of twenty dollars was passed unanimously.

Mr. A. DICKSEE kindly undertook to collect and transmit the remittances to this Fund.

Papers.

The following papers were read:

(1) "On a Lepidopterous Scavenger living in Parrots' Nests," by Dr. A. JEFFERIS TURNER.

(2) "On the mouth-parts of the Micropterygoidea," by Dr. R. J. TILLYARD.

Wednesday, March 21st, 1923.

Mr. E. E. GREEN, President, in the Chair.

Election of Fellows.

The following were elected Fellows of the Society:—Messrs. A. E. J. CARTER, "The Retreat," Monifieth, nr. Dundee; L. G. COX, 90, Marine Parade, Worthing; F. C. GARRETT, West Croft, Hexham; G. HANDLEY, 54, All Saints Road, King's Heath, Birmingham; H. NOTMAN, F.S.A., 136, Joralemon St., Brooklyn, New York; D. A. OWEN, 94, Wellington Street, Luton, Beds; L. G. SAUNDERS, B.Sc., Molteno Institute, Cambridge; E. G. R. WATERS, M.A., 40, Leckford Road, Oxford; E. J. WINSTANLEY, L.D.S., R.C.S., 25, Fellows Road, Hampstead, London, N.W.

Fund for Russian Entomologist.

Mr. A. DICKSEE reported with reference to the Fund initiated at the last Meeting for Prof. A. P. Semenoff Tian-Shanski that he had had no difficulties in making the payments, but said that after consultation with Mr. Uvarov he had divided the 40 dollars subscribed into two portions of

20 dollars each for food and clothing respectively. He had a balance in hand of 18*s.*, and asked for further contributions to make this up to 10 dollars.

Dr. M. Burr proposed, and Mr. Uvarov seconded, a vote of thanks to Mr. A. Dicksee, and suggested that the surplus might be devoted to other members of the Russian Entomological Society, many of whom are also in great need of assistance, and that a small Committee be formed for the purpose. This was carried unanimously, and a Committee consisting of Dr. M. Burr, Mr. Uvarov and Mr. A. Dicksee, with power to add to its numbers, was appointed for this purpose.

Exhibitions.

Butterflies from the Canaries.—Dr. S. A. Neave exhibited on behalf of Sir Gilbert Carter a number of butterflies collected by him in the Canaries, and read the following notes on some of them prepared by Mr. N. D. Riley.

Pararge aegeria xiphioides Stgr., a very distinct subspecies and possibly to be regarded as a distinct species if, as seems to be indicated by a specimen in the Godman-Salvin Coll. (labelled Mogador), both it and *aegeria* occur in Morocco, where the latter at any rate is common. Is a marked transition to *P. xiphia* Fab., of Madeira.

Pyrameis indica vulcania Godt., which is very common in the Canaries and occurs together with *P. atalanta.* It is easily separated from its oriental form (*P. indica indica*) by its redder coloration, wider red bands to both wings and smaller white subapical spots on fore-wing. The species is not recorded from any locality between the Canaries and India, and presents an interesting case of discontinuous distribution.

Pyrameis virginiensis Drury, an American species, somewhat similar to *P. cardui* L., that has been well established in the islands for considerably more than 100 years, as Bory mentions it as common in 1805.

Gonepteryx cleobule Hb., a close ally of *G. cleopatra* L., but generally considered distinct. The Madeira form is generally considered a subspecies of *cleopatra* : it is intermediate between the two.

Pieris cheiranthi Hb., variously treated as a good species or as a well-marked subspecies of *P. brassicae* L. It is at least quite constant and at once recognisable. In Madeira a less differentiated form, *P. wollastoni*, occurs.

Thymelicus christi Rebel, generally referred to as *T. actaeon*, but actually a distinct species.

Butterflies from Africa.—Mr. G. Talbot, on behalf of Mr. J. J. Joicey, exhibited and made remarks on the following butterflies :—

Alaena aurantiaca Btl. (Lipteninae), ♂ ♀.

"This species is considered by Aurivillius (Seitz, xiii, p. 299) to be the same as *hauttecoeuri* Ob. (Ex. d'Ent., xii, p. 7, Pl. III, fig. 9, 1888).

"The figure given by Oberthür differs in some points from specimens of typical *aurantiaca*. The fringe of the wings is shown to be white-spotted, whereas in *aurantiaca* it is black. The colour is more yellow, and on the underside the distal spots are less clearly defined and not very distinct from the ground-colour, especially on the fore-wing. Here the spot in cellule 5 is smaller than the one in 6, whereas in *aurantiaca* it is larger. There is also in Oberthür's figure, on the hind-wing below two pale basal spots in 7, whereas in *aurantiaca* there is one. The black markings below the cell are more distinct, and also the spot at end of cell.

"It appears to us, therefore, that the name *aurantiaca* must stand as representing a distinct form. This opinion was previously formed by Prof. Poulton who has further shown that *A. hauttecoeuri* is a synonym of *interposita* Btl. (Proc. Ent. Soc., 1918, p. cxxxiii).

"The ♀ is very different from any other of this sex in the group. It bears a strong likeness to the general pattern of *Acraea*, without, however, resembling any particular species. Mr. Barns says it may be easily mistaken for an *Acraea*, is slow of flight, and rests on dry twigs.

"Three ♂♂ and the unique ♀ were obtained by Mr. and Mrs. Barns, on their expedition in 1922. They were taken five days north-east of Lake Mweru on the edge of the Luvua Valley at from 4000–5000 ft., in March, middle of wet season."

Danaida chrysippus f. *dorippus* Klug.

"A ♂ specimen taken by Mr. T. A. Barns on the Tshopo-Lindi Watershed, north-east of Stanleyville, 1600 ft., April 1922.

"This record is interesting, as *dorippus* is said to occur only in the dry and steppe-like regions of the north, east, and south of Africa. This specimen is much darker than any we have seen.

"It is conceivable that this insect was one of a *chrysippus* brood, although Prof. Aurivillius gives his opinion that there is as yet insufficient evidence that these forms belong to the same species.

"If it was one of a *chrysippus* brood, and the facts of distribution do not lend support to any other interpretation, we have further confirmation that *dorippus* is an ancestral form of *chrysippus*, a conclusion reached by Col. Manders, who described his experiments in the Society's Transactions, 1912, p. 445."

A New Eligma.

Among species of the Noctuid genus *Eligma*, *E. bettiana*, sp. n., forms in some respect a link between *E. laetepicta* Oberth. (represented in Coll. Joicey from Brit. E. Africa, Tanganyika Territory, and Nyasaland) and *E. duplicata* Auriv. (distributed from the Kameruns to Nyasaland).

It will be noticed that the subterminal markings and posterior third of fore-wing and the pattern of hind-wing much more nearly approximate to *E. duplicata* than to *E. laetepicta*, whilst in the coloration (especially the shining blue-black of the dark areas) and the yellow fasciation of the fore-wing *E. bettiana* more nearly approaches towards *E. laetepicta*.

E. bettiana was taken by Mrs. T. A. Barns on the Marungu Plateau, S. W. Tanganyika, at 7000 ft., in Feb. 1922.

A description of this species will appear shortly in the Entomologist.

Exotic Carabids.—Mr. H. E. Andrewes exhibited *Tachys euryodes* Bates, from Sarawak, *T. triangularis* Nietner, from Bengal, and *T. captus* Blackb., from New South Wales, and

called attention to the two large rounded pores on the mentum in these species.

THE SERIES OF HEODES PHLAEAS PSEUDOPHLAEAS LUCAS, IN THE TRING MUSEUM.—Prof. POULTON said that he had been kindly permitted by Lord Rothschild to exhibit a fine series of nineteen *pseudophlaeas* from Abyssinia. With the exception of a single male taken in October 1905 at Adi Ugri, Eritraea, by N. Beccari, all the specimens, seventeen males and one female, had been collected in 1900 as follows:—

Harar, by Erlanger and Neumann: Apr. 7—1.

Abd-el-Kadr, S. of Harar, by Erlanger and Neumann: May 15—1.

Gara-Daij (Abunass), 2500–2800 m., by Erlanger and Neumann: July 10—1.

Djidda-Oborassa, 2800 m., by Erlanger and Neumann: July 21—1.

Managascha, Schoa, by O. Neumann: Sept. 15—1.

Kollu, Schoa, by O. Neumann: Sept. 21—1.

Akaki River, S. of Adis Abeba, by C. V. Erlanger: Oct. 23—2; 25—1; 31—1; Nov. 2—1; 2 to 11—2; 5—1 (the single female); 14—1.

Roba, N. of Lake Abassa, by C. V. Erlanger: Dec. 3—1; 4—1.

Lake Abassa, by O. Neumann: Dec. 8—1.

Although the specimens as a whole were in poor condition they afforded a most valuable means for testing the description of the smaller number—14 and 3 respectively—in the British and Paris Museums (Proc. Ent. Soc. Lond., 1922, pp. li–lvi). This test was of the greater importance because all the characters described tend to vary within fairly wide limits.

The black spot near the anal angle of the fore-wing was slightly curved, with concavity inward, viz. towards the base of the wing, on one or both sides, in five individuals,—slightly outward in five others. When not so curved it was straightish or irregular in shape. In four individuals, including the female, there were distinct indications of doubling on one or both sides.

The hind-wing of several specimens showed a *very* slight

indication of the second "tail" and of the "échancrure" or bay in the margin between it and the prolonged anal angle, which latter was, as usual in *pseudophlaeas,* strongly marked in comparison with *phlaeas phlaeas.*

The scalloping of the inner border of the red marginal band of the hind-wing upper surface was as described (*ibid.*, p. lv), being slightly marked as compared with *ethiopica.* The band itself was much broader than that of *phlaeas.*

The coppery lustre overspreading the black surface of the hind-wing was strongly developed in nearly all the specimens, particularly in the one from Kollu and one from Roba (Dec. 3)—two out of the three males with indications of a divided spot in the fore-wing (p. xxii). Blue spots inside the red marginal band could only be detected in two males, and were *very* slightly developed in these.

The reddish under-surface of the wings and the pale or white underside of the abdomen were as described (*ibid.*, p. lvi).

On the whole the Tring series of *pseudophlaeas* was remarkably consistent with that previously described, and, like it, indicated that the Abyssinian subspecies approaches nearer to *abboti* than does *ethiopica,* which penetrates much further into the continent and exists in much closer proximity to *abboti.* This approach of *pseudophlaeas* towards *abboti* was especially evident in the great development of coppery lustre over the hind-wing.

Arranging the 19 examples in the order of date brought out no suggestion that there were seasonal differences. If these existed they must be very small and would require large numbers for their establishment.

There was the same want of evidence for seasonal change in *H. phlaeas ethiopica,* of which 34 examples with dates are now known—11 taken by Dr. G. D. H. Carpenter, Jan. 23–Feb. 23, 1916 (Proc. Ent. Soc., 1921, p. lxxxi), and 11 more Aug. 22–Sept. 8, 1922 (Proc., 1922, p. xciv), and 12 by T. A. Barns, July–Oct. 1919 and Sept. 1921 (Proc., 1922, p. lii). All of these were collected in or near the Western Rift Valley, and their comparison did not suggest any seasonal difference. Nor did there appear to be any evidence of such differences in *H. phlaeas abboti.*

H. phlaeas phlaeas of the Northern Belt, on the other hand, was undoubtedly sensitive to seasonal changes, the effects being noticeable even in this country (Proc. Ent. Soc., 1912, p. cxxxviii; 1921, p. cvi), and strongly marked in the southern part of its range. Why then should the three Ethiopian geographical races exhibit none of this sensitiveness in a region where seasonal dimorphism of butterflies is more highly developed than in any part of the world? The answer may probably be found in the fact that all three races were inhabitants of high elevations where the seasonal differences were greatly reduced.

EXAMPLES OF HEODES PHLAEAS PHLAEAS L., FROM THE SAHARA, IN THE TRING MUSEUM.—Prof. POULTON said that, by the kindness of Lord Rothschild, he was able to exhibit five Saharan examples of this species—2 males and 2 females from El Biar, and 1 female from Casba. The blue spots on the hind-wing could be made out in all of them, were fairly distinct in two and quite so in one. Mr. E. B. Ford, of Wadham College, Oxford, who was engaged in a comprehensive study of *phlaeas phlaeas*, had observed that the upper surface of two of these butterflies approached that of *phlaeas pseudophlaeas*, and had kindly written the following detailed account:—

"*Heodes phlaeas phlaeas* is subject to an almost endless series of modifications, and it varies seasonally and geographically to a remarkable extent. Nowhere, however, in the Palaearctic Region is it known to resemble the form found in Abyssinia, nor is such a form known to occur in it even as a rare aberration. It is of some interest therefore to find a female specimen taken at El Biar (27·35 N., 9·12 W.) approaching the Abyssinian type. On the upperside the resemblance may even be described as striking. The coppery surface is very bright and has assumed a fiery red-brown tint; the hind-wings have a remarkably broad red band and are thickly dusted with iridescent scales even up to the base. Indeed, on the upper surface, this specimen might well pass for an Abyssinian insect. The underside of the hind-wings, however, is grey, typical of the spring specimens from the Palaearctic Region of N.W. Africa: in the summer broods

this is changed to a purplish-brown, shading off to a dust colour, but perfectly distinct from the rich red-brown found in specimens from the Ethiopian Region.

"Among the three other specimens from the same place, and one from Casba (40 miles N.E.), there is but little tendency to a repetition of the same form; in the Casba example, however, a female, the hind-wings have a broad red band on the upperside, and a coppery lustre over the black surface. This last character also appears in a male from El Biar. It is a curious circumstance that the spot on the fore-wings nearest the inner angle is not curved, with concavity outwards, in any of these specimens, except very slightly in one example. In the specimen nearest the Abyssinian form all the spots are much reduced and this one is divided. This direction of curvature can have but little significance in only five insects, but the reverse condition might well have been expected, for, in specimens from N.W. Africa, it is distinctly curved outwards in 52 per cent., inwards in 18 per cent. (calculated from 530 specimens from Morocco and Algeria)."

PARARGE MADERAKAL GUÉR., AN ETHIOPIAN "WALL BUTTERFLY."—Prof. POULTON exhibited two female examples of this species, collected, in December 1905 or January 1906, by his friend Sir Horace Byatt at Upper Sheikh (5000 ft.) in the Golis Mountains, 48 miles south of Berbera. The late Mr. H. J. Elwes, F.R.S., who was very interested in the specimens, considered them to be *P. maera* L., but Capt. N. D. Riley had proved by the examination of the armature in a single male *maderakal* from Abyssinia, in the National Collection, that this species is nearer to *hiera* F., although evidently distinct, as shown by the form of the uncus. He also found that the claspers of *maderakal* and *hiera* were similar, but differed from those of *maera*. The upper surface pattern of the two exhibited specimens, which differed greatly in size, strongly resembled that of *maera*. This was especially true of the larger example, which moreover in size fully equalled the female of *maera* and greatly surpassed the average of this sex in *hiera*. Considering these facts and the very close relationship between all three species, Mr. Elwes' determination was not at all surprising.

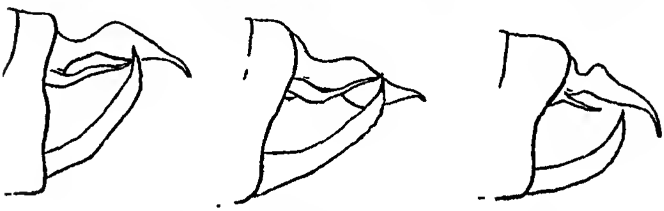
Capt. Riley had kindly recorded the distribution of the three species as represented in the National Collection :—

"*P. maera*—Europe (except Denmark, Holland, and the British Isles), Siberia, Persia, Syria, Asia Minor, Morocco.

"*P. hiera*—Scandinavia, Pyrenees, Switzerland, Italy, Hungary, Balkans, Russia, Siberia.

"*P. maderakal*—Abyssinia."

P. hiera was more of a mountain species than *maera*,— another indication of affinity with *maderakal*. This latter was probably quite common in the locality where Sir Horace Byatt captured the two butterflies. The late Dr. G. B. Longstaff had recognised another specimen among a few



1 2 3

Genitalia of (1) *Pararge maera* L. (2) *P. hiera* F. (3) *P. maderakal* Guér.

butterflies obtained by a friend in Somaliland, and the independent occurrence of the species in two smallish collections from the same area indicates that it cannot be rare.

The distribution of these three nearly related "Wall Butterflies" was extremely interesting—two of them exclusively Palaearctic, and the third, so far as we know, entirely Ethiopian, and, without itself undergoing any marked change, taking its place in a fauna utterly different from that which surrounds its close allies in the north.

Papers.

The following papers were read :—

"A Contribution to our knowledge of the Orthoptera of Macedonia," by Dr. M. Burr and others.

"On the Homology between the Genitalia of some species of Diptera and those of *Merope tuber*," by Mr. F. Muir.

"Records and Problems of Insect Migration," by Mr. C. B. Williams.

Wednesday, April 4th, 1923.

Mr. E. E. GREEN, President, in the Chair.

Election of Fellows.

The following were elected Fellows of the Society:—Mr. G. F. GEE, Mouldsworth, nr. Chester; Mr. J. B. HICKS, 99, Barkston Gardens, S. Kensington, S.W. 5.

Exhibitions.

LEPIDOPTERA FROM EAST TYRONE.—Mr. THOMAS GREER, a visitor, who expressed his thanks for the opportunity given him of attending the Meeting, exhibited the following Lepidoptera from East Tyrone:—

Pieris napi.—A series including ♂♂ with an additional spot on fore-wings and a banded form; ♀♀ pale yellow, banded forms and examples with three spots on hind-wings.

Euchloë cardamines.—Well marked ♂♂ of race *hibernica* Wms.; ♀ with chrome yellow hind-wings. Two ♀♀, May 1922, with the orange coloration of the ♂.

Pyrameis atalanta.—An example with the brown shades on underside of hind-wings much extended.

Dryas paphia.—♂ with pale spots on fore- and hind-wings, upperside.

Melitaea aurinia.—A varied series including vars. *hibernica* and *scotica*.

Pararge megera.—A series including extra spotted forms.

Epinephele jurtina.—A varied series with ab. *addenda* and richly marked undersides.

Caenonympha pamphilus.—♂ with two dots on upperside of lower wings on margins near the *anal* angle.

Lycaena icarus.—♂♂ with red, as well as black dots on margin of hind-wings, upperside. ♂ var. *postico-obsoleta* Tutt. ♂ and ♀ undersides, fore-wings with a white dash from discoidals towards the base.

Eupithoecia succenturiata, *E. sub-fulvata* and *E. pygmeata*.—A series of each of these species.

Diaphora mendica.—A varied series including ochreous and pale brown forms; var. *rustica*.

A New African Satyrid.—Mr. N. D. Riley exhibited the male and female of a new Satyrid butterfly from E. Africa :—

Aphysoneura obnubila sp. n.

♂♀. *Upperside, both wings.*—Dark brown, almost black, with small pale ochreous markings, *Fore-wing.*—The pale markings consist of a fairly wide transverse bar across cell to costa, arising at and beyond origin of vein 1; a similar, but rather narrower bar just beyond cell end from costa almost to vein 4; a small, round subapical spot and two similar spots below, in areas 4 and 3, and a large irregular pale mark occupying the greater part of the central portions of areas 1*b* and 2 in the female, considerably smaller, especially in area 1*b* in the male. There are indications of a dark ocellus in area 5; cilia dark brown, paler between the veins. *Hind-wing.*—The pale markings consist of only a discal very irregular patch occupying the proximal third of area 3, about ⅔ centrally and diagonally of area 4 and a small contiguous area in area 5. Ocelli are indicated distally in areas 1*c*, 2, 5 and 6. The lobe-like production of the wing at vein 2 is filled with brownish-crimson. The marginal and anteciliary dark lines are separated by a pale line, and the dark cilia are marked with paler as on fore-wing.

Underside, both wings.—The pale markings of upperside repeated and enlarged, the dark markings not so dark. *Fore-wing.*—The pale markings almost white towards costa; the isolated subapical spot joined with the others to form a diffuse band enclosing a well-developed ocellus; marginal area pale buff, tapering to a point at vein 1; base of cell also buff. *Hind-wing.*—Basal area pale brownish, marked with pale grey; subbasal area pale grey, marked across cell-end, in base of area 2 and obscurely in area 1*c* with pale brown, and bounded by a broken line consisting of a heavy crescentic mark anteriorly and a broad V-shaped mark, slightly toothed at vein 2; discal area pale brown, ochreous where ochreous on upperside, containing a series of six ocelli, of varying size, the lowest (in area 1*c*) double; marginal area pale greyish, heavily suffused with pale brown; otherwise as above.

Length of fore-wing, ♂ 23; ♀ 25 mm.

Type. ♂, "Nyasa" (*A. Sharpe*); ♀ Tanganyika Territory, Slopes of Mt. Rungwe, nr. N. Langenburg, 5000–6000 feet, 21. xi. 1910 (*S. A. Neave*), both in B.M.

The species is at once distinguishable from any of the forms of *A. pigmentaria* Karsch, the only other species in the genus,

by its upperside. *A. pigmentaria* has the bulk of the fore-wing and almost the whole of the hind-wing pale ochreous, whereas in *A. obnubila* the upperside is mainly dark brown, the pale ochreous markings being only of comparatively small extent. On the underside the main difference is in the V-shaped mark on the hind-wing referred to in the description. This is always much more produced in *A. pigmentaria* than in *A. obnubila* and also throws off a subsidiary V-mark of considerable length along vein 2.

A. pigmentaria has recently been subdivided into three races by M. le Cerf (Bul. Mus. Paris, p. 163, 1919), who states that the typical race is confined to Usagara in Tanganyika Territory. It was originally described by Karsch from Mlalo in Usambara, which lies a very considerable distance to the north-east, in fact in the north-east corner of Tanganyika Territory. It is highly probable, however, that the same race inhabits the two areas. In Kenya Colony the species occurs at Lumbwa in a form which I cannot separate from typical *pigmentaria*, whilst on Mt. Kenya and apparently about Kikuyu there occurs the rather distinct race, with narrower black marginal markings on the hind-wing, named *pringlei* E. M. Sharpe (P.Z.S., 1894, p. 336). This appears to me to be identical with the var. *keniae* of M. le Cerf (*l. c.*).* The Nyasaland race is named *latilimba* by Le Cerf, for obvious reasons, and is fairly constant.

Dr. S. A. Neave said that in his experience all the species of this genus are confined to the edges of forests in mountainous country, often at fairly high elevations, and are remarkably active on the wing for Satyrines. He had found the Nyasaland race to be extremely common on Mt. Mlanje.

A rare British Hymenopteron.—The Rev. F. D. Morice exhibited a British specimen of the strange Hymenopterous insect which was described first by Spinola in 1840 as *Trigonalys hahni*, and again a year later by Shuckard as *Trigonalys anglicana*. It is now placed in a genus of its own—*Pseudogonalos* Schulz, Westwood's name *Trigonalys* being restricted to certain American species of the same Family, of which *P. hahni* is the only European representative.

[* M. le Cerf (in *litt.*) agrees that this is so.]

The general appearance and especially the alar neuration of the insect are those of a Fossorial Aculeate, but its double trochanters and multiarticulate antennae seem to dissociate it from that group, and it is now generally believed—though quite conclusive evidence on the point is still lacking—that it is in some sense a parasite or inquiline, and that its probable victims are various Social Wasps. An American species has been found in a nest of *Polistes*, and seems to be a mimic of the latter insect; but there is no similarity of appearance whatever between *P. hahni* and any European *Vespa* or *Polistes*, nor has it ever been found in nests of the latter, though Dr. Steck has not unfrequently met with it in Swiss localities where such nests abound, and strongly suspects that this is not a mere coincidence. Westwood, Ashmead, and Schmiedeknecht, agree in thinking that the Family most nearly related to the Trigonalyidae is that of the Mutillidae, and it is well known that *Mutilla europaea* has been found in nests of Humble-bees, while André in vol. viii of "*Species,*" pp. 36–40, cites many observations of parasitism by species of Mutillidae on all kinds of nest-making Hymenoptera "des Sphégides, des Pompilides, des Vespides et des Apides, chez lesquels ils ont été observés."

A rare Colias.—Mr. H. J. Turner exhibited a short series of *Colias behri*, Edw., from the Yosemite Park, where it had been found in large numbers at an elevation of 9,700 feet.

Wednesday, May 2nd, 1923.

Mr. E. E. Green, President, in the Chair.

Election of Fellows.

The following were elected Fellows of the Society:—Dr. R. C. Lowther, M.B., Ch.B., Fernleigh, Grange-over-Sands, Lancs.; Mr. John D. Sherman, Junr., 132, Primrose Avenue, Mount Vernon, New York, U.S.A.

Wicken Fen Fund.

The Treasurer made a statement on the financial position of the Wicken Fen Fund, and made an appeal to Fellows for further contributions.

Exhibitions.

THE TYPES OF ARGYNNIS AGLAIA SCOTICA WATKINS.—Mr. W. G. SHELDON exhibited the types of both sexes of *Argynnis aglaia scotica* described in the Entomologist, lvi, p. 109, from Lochinver, Sutherlandshire, with examples of both sexes of typical *A. aglaia* from Scandinavia for comparison.

A MONKEY'S MEAL OF LEPIDOPTEROUS LARVAE AND PUPAE.—Prof. POULTON said that he had received the following note in a letter from Mr. G. F. Leigh written, November 21, 1922, from Durban :—

"We have a tame monkey which my wife and daughter are very fond of, and on October 16 she got loose, entered my room, opened my breeding-cages and had the following meal :—

"*Papilio dardanus* Brown—45 mixed larvae and pupae.

"*Papilio nireus* L.—12 mixed larvae and pupae.

"*Temnora zantus* Herr.-Sch.
"*Temnora murina* Walk. } 9 pupae.

"*Oligographa juniperi* Boisd.—pupa.

"She then began on a few pupae of *Rhopalocampta keithloa* Wallgrn., but either did not fancy these or probably had had quite enough. I never thought that larvae of Papilios would be eaten by any animal or bird."

This interesting accident showed how erroneous it was to infer that an insect is necessarily palatable because it is devoured by an insectivorous animal in captivity. Such an animal, with an appetite sharpened by the want of its natural food in normal variety, would be likely to devour eagerly insects which in the wild state it would only take when more palatable species were absent.

SOME STRIKING EXAMPLES OF MIMICRY IN BUTTERFLIES FROM THE FEDERATED MALAY STATES.—Prof. POULTON said that the Hope Department had recently received the insect collections of the late Rev. J. W. B. Bell, who, when a schoolmaster in Oxford, had once taught two of our Fellows—Major

C. A. Wiggins, C.M.G., late P.M.O. of the Uganda Protectorate, and Capt. W. A. Lamborn. Both these naturalists, who had done so much to increase our knowledge of African insect life, had told him that they owed their interest in the subject to Mr. Bell's influence upon them when they were about ten years old.

Mr. Bell's cabinets contained a fine set of Lepidoptera collected in the F.M.S. by his son, Mr. Vernon G. Bell, and it was interesting to observe the manner in which the arrangement of some of the species had been influenced by mimetic resemblance.

Papilios of the helenus group and the Satyrine Neorina lowii Hew.—In one of the drawers three examples of *Papilio fuscus prexaspes* Feld., were followed by one of *Neorina lowii neophyta* Fruhst., the striking resemblance in pattern and especially the hind-wing "tails" successfully developed by the Satyrine mimic having naturally suggested affinity. In other parts of the collection were examples of a second model, viz. *Papilio nephelus saturnus* Guér., but one which was far less effective than *prexaspes* because of the conspicuous oblique white bar crossing the fore-wing, a feature absent from the two first-named species.

Being anxious to ascertain the facts about the occurrence together of Papilios of this group and the Satyrine mimic, Prof. Poulton had written to his friend Mr. H. C. Robinson, Director of the State Museum, Kuala Lumpur, who had kindly replied, January 25, 1922:—

"As regards the *Papilio* and *Neorina lowii* I send you a table, compiled by Capt. H. M. Pendlebury, of the specimens in our collection from which you will see that the species occur together at the same date. We have, however, no specimens of *P. fuscus prexaspes* in our collection, and in the Malay Peninsula it must be a species of very restricted habitat or extreme rarity. I am inclined to query certain recorded localities such as Kuala Lumpur (Biggs quoted by Distant).

"As regards habits I know all the species in the table well. In flight *Neorina lowii* is a typical Satyrine with a slow fluttering and rather deliberate flight. It is much more of a jungle form, flying mainly in late afternoon, and does not like strong

light. It is far less powerful in its flight than the Papilios, and is individually less numerous. We will shortly send you specimens of all forms caught as nearly as possible on the same day, but in all cases our collectors have not invariably noted the day of the month."

	Papilio helenus helenus L.	*Papilio iswara iswara* White.	*Papilio nephelus saturnus* Guér.	*Neorina lowii neophyta* Fruhst.
Kedah.	Gunong Terei, 3500 ft., June 22, 1921 (Evans).	Gunong Terei, 3500 ft., June 19, 20, 27, 1921 (Evans); Kedah Peak, 3500 ft., Nov.–Dec. 1915.		
Perak.	Batang Padang, Feb. 23, 26, and 28, March 1 and 2, 1915.	Batang Padang, Feb. 24 and March 1915.	Batang Padang, Feb. 24, 28, and March 1915.	Batang Padang, Feb. 25, and March 1915.
Pahang.	Kuala Teku, March 9, 1921; The Gap, Jan. 1915.	Kuala Teku, Feb. 1921.	Kuala Teku, Feb. 1921; K. Tahan, March 1921; Tembeling River, 1921.	Kuala Teku, Feb. 14, 1921.
Selangor.	Bkt. Kutu, 3400 ft. Sept. 8, 1910; Ulu Langat, Nov. 11, 1911.	Ginteng Sempak, 1200 ft., Oct. 21, 1921.		Ulu Langat, Nov. 18, 1916; Ulu Gombak, July 1915.
Negri Sembilan.			Bukit Tangga, Sept. 1915.	
E. Coast.	Tioman Is., June–July 1916.			

In addition to the above species of *Papilio* and *P. fuscus prexaspes*, Dr. Karl Jordan had kindly pointed out that *P. iswaroides curtisi* Jord., superficially exactly like *helenus*, formed another member of the group in the F.M.S.

To this table Capt. Pendlebury had kindly added his own experience of the behaviour of models and mimic in the field.

"So far, I have only seen two specimens of *N. lowii neophyta* Fruhst., on the wing, and the difference in flight from any of the three Papilios mentioned was noticeable, especially two (*P. iswara iswara*, and *P. nephelus saturnus*) which occurred in the same locality, very sparingly, and did not fly about together. All the Papilios I have so far seen, when settled, vibrate their wings rapidly which *N. lowii* does not do. *N. lowii*

when settled rests with its wings half open.—H.M.P., Jan. 25, 1922."

The differences in flight and habits were what we should expect in these models and their mimic. The habit of fluttering as they stand, as it were "tip-toe," on alighting was ingrained in the Papilionine constitution and had evidently been inherited from a common ancestor in the remote past. Even the most perfect of the mimetic Papilios retained this habit although quite different in this respect from their Danaine models. Thus, Canon St. Aubyn Rogers has recorded that "in nature the *Papilio echerioides* [Trim.] female is much nearer to the primary model [*Amauris echeria* Boisd. and *A. albimaculata* Butl.] than the other female Papilios, and, were it not for the characteristic habit of hovering nervously over a flower, it would be very difficult to distinguish it from the *Amauris*" (Trans. Ent. Soc., Lond., 1908, pp. 517, 518). Since the *Papilio* when a mimic could not get rid of this revealing feature it was not surprising that the Satyrine had been unable to evolve it. The fact that the latter sought deeper shade than its models could be paralleled by many instances. Model and mimic would almost certainly overlap along the adjacent borders of their respective ranges, and forest of various depths of shade would be traversed by at any rate some of the flying enemies.

The Chalcosiine (Zygaenid) moth Isbarta pieridoides H.S., ♀, *and its Hestia (Danainae) Model.*—In another part of Mr. Bell's cabinet a female *Hestia logani* Moore and three examples of *Ideopsis (Gamana) daos perakana* Fruhst. were followed by a female of the Chalcosiine moth mimic. It seemed curious that Herrich Schäfer should have given the name *pieridoides* to this species, the resemblance to the *Ideopsis* being so strong and obvious. The mimicry of butterflies by the females, but not the males, was also found in other Chalcosiine moths as had been pointed out by Lord Rothschild in his recent Presidential Address (Proceedings, 1922, p. cxxv).

Capt. Pendlebury had kindly given an account of his experience of *Ideopsis* and its mimic and had added a new and interesting example of a Chalcosiine mimic:—

"With reference to the photograph of *Ideopsis* and *Isbarta*

from the Rev. J. W. B. Bell's collection, we have specimens of *Ideopsis daos perakana* Fruhst., which have been caught throughout the Peninsula. On the other hand, the only example of the Zygaenid (Chalcosiine) moth (*Isbarta pieridoides*) I have so far seen was in the collection of a Mrs. Souter, who had included it with specimens of *Ideopsis daos* in a box of butterflies. Unfortunately she could give me no definite data concerning it.

"I managed to catch at Ginteng Sempak, about 24 miles from Kuala Lumpur on the Selangor-Pahang border (1500 ft.) a really good mimic of *Papilio aristolochiae aristolochiae* L. This was a Zygaenid (Chalcosiine) moth of the genus *Histia*, a species allied to *cometaris* Butl.* I caught it about midday on Oct. 21, 1921, and while flying it looked very similar to a *Papilio aristolochiae* which had had its 'tails' slightly mutilated—only I never saw a single specimen of *P. aristolochiae* in that locality at all during the fortnight I was there.

"The nearest places to this from which we have records of the capture of *Papilio aristolochiae* being caught are Ulu Gombak (16th mile from Kuala Lumpur, eight miles from Ginteng Sempak): June; Bentong (48 miles from K. Lumpur): July.

"H. M. Pendlebury, Jan. 25, 1922."

A white-hind-winged race of Danaida chrysippus L., developed probably in mimicry of D. melanippus hegesippus Cr., in the neighbourhood of Kuala Lumpur.—Distant, in "Rhopalocera Malayana" (1882–1886), figured and described the type form of *chrysippus* (p. 20, pl. I, fig. 10), but in the later part of his work also figured (pl. XL, fig. 13) a white-hind-winged variety taken at Singapore. Major J. C. Moulton, M.A., B.Sc., in "Journ. Fed. Mal. States Museums," X, June 1921, pp. 173, 174, after stating that the type form is "apparently rare in the Malay Peninsula," spoke of a series of white-hind-winged forms from Kuala Lumpur "bred from larvae found on a large Calotropis growing in the Agricultural Plantation in January 1919."

That this *alcippus*-like butterfly was probably the only

* This black moth, with its red body, white patch and "tails" to the hind-wing, and curious striated appearance of the fore-wing, certainly seems to be a mimic of *P. aristolochiae.*—E. B. P.

form of *chrysippus* at Kuala Lumpur was proved by a series of thirty specimens—16 males and 14 females—received by Prof. Poulton from Mr. W. A. Lamborn, who bred them, Jan. 25–Feb. 2, 1921, from scattered larvae found on an Asclepiad shrub in the Plantation mentioned by Major Moulton. Every specimen was fully as white-hind-winged as the typical *alcippus* from the West Coast of Africa.

Two sets of five each were exhibited to the meeting. One of these was selected to show the increasing size of the white spots in areas 3, 2, and 1*b* of the fore-wing, this last spot being absent in the uppermost specimen which also had the smallest spot in area 3. This topmost butterfly was, in this respect, nearest to the African race, the other four being in an increasing degree typically far-eastern. In the second set of five the strong development of these white spots was accompanied by a tendency of the white scales to overspread the apical black of the fore-wing. The set was arranged to show an increasing development of this tendency which was strongly marked in the last specimen.

There was little doubt that this remarkable eastern race with so restricted a range had been developed in mimicry of the common Malayan *Danaida melanippus hegesippus* of which Distant wrote (*ibid.*, p. 19, pl. 2, fig. 1):—This form "has become the dominant race in the Malay Peninsula, whilst the form *D. melanippus* is, as far as I am aware, absent." Major Moulton agreed with this conclusion (*ibid.*, p. 176).

It was furthermore highly probable that the white-hind-winged form of *Danaida plexippus* L. (*genutia* Cr.), named *intermedia* by Moore, was another member of the same association. Distant spoke of this variety with hind-wing "much suffused with white" (*ibid.*, p. 18, pl. 2, fig. 3) as "not infrequent," while Moulton, after referring to its existence in this area, pointed out (*ibid.*, pp. 174–5) that it "cannot be regarded as a separate subspecies" because of the transitional varieties by which it is linked to the typical form occurring side by side with it. In the immediate neighbourhood of Kuala Lumpur the *intermedia* form may, however, predominate or at any rate be more strongly represented than elsewhere in the Peninsula.

Mr. Lamborn's captures at Kuala Lumpur, tabulated below, proved that all three forms occur together and may be taken at the same place and time.

Dates in 1920.	*D. melanippus hegesippus* Cr.	*D. chrysippus alcippus* Cr.	*D. plexippus intermedia* Moore.
March 28	1 ♂	1 ♂	
April 1		1 ♀	
„ 11	2 ♂	2 ♂, 1 ♀	
„ 18	1 ♂		
„ 19	1 ♂		1 ♂
Dec. 27		1 ♂	

That the area in which the white-hind-winged *chrysippus* is the only form is very restricted was indicated by a collection made by Mr. A. R. Sanderson, F.L.S., of the Research Laboratory, Petaling, F.M.S.—a collection which also supplied evidence for the existence of the white-hind-winged Danaine association. Mr. Sanderson's specimens of these forms and their allies, collected in Selangor over an area less than 40 miles N.E., S.W. and E. of Kuala Lumpur in 1920, were as follows:—*melanippus hegesippus*: 2 ♂, 2 ♀; *plexippus intermedia*: 4 ♂, 2 ♀, two being transitional; *plexippus* (*genutia*): 2 ♀; *chrysippus alcippus*: 1 ♀; *chrysippus* (typical): 1 ♂, 1 ♀

It seemed remarkable that this association should have escaped notice for so long a time and that the white-hind-winged *chrysippus* from Kuala Lumpur should until now have been wanting from the principal collections in this country.

THE UPPER-SURFACE PATTERNS OF BUTTERFLIES SEEN FROM BENEATH IN A FLOATING FLIGHT.—Mr. W. J. KAYE exhibited several Nymphaline butterflies and one day-flying Geometrid moth to call attention to the essential appearance of the upperside when in flight. In December last an exhibit was made of *Protogonius*, when it was demonstrated, after having been observed in the field, how the upperside only was seen in flight even when viewed from beneath (Proceedings,

1922, p. xcviii). The cases now brought forward, while not as striking as the *Protogonius*, sufficiently illustrated the phenomenon that, in spite of a differently coloured underside, the upperside was displayed as a transparency or a semi-transparency, the colouring of the underside to a large extent disappearing against the light. The examples shown were *Coenophlebia archidona*, a butterfly that undoubtedly derives protection from the large Müllerian group of which *Melinaea mothone* and *Heliconius aristiona* form the centre. The wonderful protective colouring of the underside of *C. archidona* when held against the light largely disappears, and even the large metallic blotches merge in the general colour of the upperside that shows through. The leaf-like midrib conversely shows through to the upperside as a transparency, but with reflected light the midrib is not observable on the upperside.

Aganisthos odius, another species with a protective underside, shows the large ochre band when viewed from beneath against the light. In such a heavily scaled insect this is especially remarkable, when in addition the underside pattern is so totally different and no indication of the upperside pattern is to be seen except as a transparency. *Siderone* species are similar in having a more or less dead-leaf-like underside, but at the same time exhibiting the red patches of the upperside when in flight.

Limenitis sibylla, which has been observed on the wing by a large proportion of Entomologists, is always a black-and-white butterfly in flight, the brown colouring of the underside appearing like the dark upperside when held against the light. Large numbers of British Entomologists will be able to observe this species for themselves now that the point has been raised.

Vila azeka, of which an upper- and underside were shown to emphasise the dissimilarity of colouring, was called attention to for a similar phenomenon to the foregoing. The clearly cut outline of the whitish transparent marks of the fore-wing on the upperside were by "camouflage" largely altered on the underside, yet against the light the upperside shape of the marks clearly became visible. The mark in the cell and the mark between veins 2 and 3 were particularly noticeable in

this respect, while in the hind-wing the whitish transparent area of the upperside was much narrower than on the underside; yet as a transparency the upperside area was what was visible and not the pseudo-larger area of the underside, which was largely brought about by whitish and not transparent scaling.

Erateina garleppi, a strikingly beautiful day-flying Larentiine Geometrid moth, was a similar case to *Vila azeka*. On the upperside there is a discal transparent band and the small apical transparent spot. On the underside these same areas are continued to costa and to inner margin by white scaling, so as to alter their shape. Similarly, on the underside of the hind-wing the long transparent band is continued by white scaling to the costa in one direction and to the inner margin in the other. As a transparency against the light the white scaling disappears, and the greatly altered appearance of the upperside is what is seen.

Prof. Poulton said that Mr. Kaye was to be warmly congratulated on his most interesting discovery which had already given us a new point of view in the study of butterfly patterns. He believed that the meaning of the adaptation was to facilitate the recognition of patterns associated with unpleasant experiences, in the memory of enemies. Mr. C. F. M. Swynnerton had shown that enemies' attacks were determined by their state of hunger at the time. According to the degree of hunger or repletion they would pursue or ignore a species with a pattern suggesting a certain standard of unpalatability. It was important therefore that mimicking species with procryptic under surfaces concealing them when at rest, and also similarly concealed non-mimetic species protected to a certain extent by unpalatability, should display during flight, from below as well as from above, the upper-surface pattern or some characteristic part of it.

It was necessary to bear in mind, in relation to this complex double adaptation—procryptic protection at rest, aposematic display during flight—that the perfect insect, which had already surmounted the dangers of the three earlier stages, was of much greater value to the species than a pupa, just as a pupa was of much greater value than a larva and a larva than an egg.

In writing to Mr. G. F. Leigh of Durban, Prof. Poulton had mentioned Mr. Kaye's discovery, and in his reply Mr. Leigh said that he would watch the flight of *Precis ceryne* Boisd., from this point of view. On January 19, 1923, he wrote again as follows :—

" With regard to *Protogonius* I find that the colours of the upperside of *Precis ceryne* Boisd. also show through the leaf-like underside when flying. I captured several two or three days ago, and I think the reason it has not been noticed before is because the butterfly rarely flies high enough to see it. I had to make them fly up myself, and I take it, it is only when at rest that the butterfly requires to hide itself or rather its showy colours. I quite expect *Precis tugela* Trim., is similar in this respect to *ceryne*."

Mr. Leigh wrote again on March 12 :—" *Precis octavia natalensis* Staud., shows the upper-surface pattern very plainly from beneath when on the wing—more so than *P. ceryne*."

Prof. Poulton had also observed the transparency of set specimens of *natalensis* and that they contrasted sharply in this respect with the dry-season form *sesamus* Trim.

THE OPTICAL INTERPRETATION OF THE VISIBILITY OF THE UPPER- WHEN LOOKED AT THROUGH THE UNDER-SURFACE PATTERN OF CERTAIN BUTTERFLIES.—Prof. POULTON said that he had sent the wings of a *Protogonius* mounted as for lantern projection to Lord Rayleigh, F.R.S., who had kindly replied, April 7, 1923 :—

" I have examined the butterfly wings. It seems to me that the explanation involves no special difficulties from an optical point of view.

" I refer to the two pictures as the ' butterfly pattern ' and the ' leaf pattern.' The salient fact is, I think, that the butterfly pattern is characterised by an absolutely opaque pigment in the shades. There is nothing comparable in opacity in the leaf pattern. It follows therefore that when we see the wings by transmitted light only, the butterfly pattern must predominate. No light can get through the dark parts of this pattern, whereas light can penetrate tolerably all other parts of either pattern.

" If therefore we hold the specimen against the glass of the

window (no other window in the room) we *must* see the butterfly pattern, even though the leaf side faces the observer.

"Now take the other extreme case, when we view the specimen *wholly by reflected light.* For this purpose it is sufficient to lay it with the butterfly side against a black surface, say the outer boards of a book bound in black. In this case I am unable to see any trace of the butterfly pattern at whatever angle the specimen may be held to the light, or to the line of the observer's eye. The leaf pattern only is seen.

"Let us now pass to the intermediate case. Remove the black background; the light reaching the observer's eye will now come in part by transmission through the specimen, in part from reflexion at the surface (leaf surface towards the observer). The former shows the butterfly pattern, the latter the leaf pattern, and which of these predominates depends on whether the transmitted or the reflected light is the brighter. If you turn it to various angles you will in general alter the illuminations, and vary the appearance. But it is more satisfactory to hold the specimen between two windows on opposite sides of a room, or between two lamps, leaf side to observer, who brings the specimen towards a window, *as he does this* holding it parallel to its original position, and more or less in front of him, taking care not to obstruct the light with his head. As he goes near the window the transmitted light predominates, and the butterfly pattern comes into view."

In answer to a further letter inquiring about the darker parts of the leaf pattern which cross the lighter parts of the butterfly pattern, Lord Rayleigh kindly wrote on April 17 :—

"I think that the darker parts of the 'leaf pattern' fail to appear in transmission because attention is diverted from them by the overwhelmingly stronger contrasts produced by the absolutely opaque black pigment of the 'butterfly pattern.' This is, I think, substantially what you yourself suggest.

"It would, I think, be easy for anyone accustomed to use water-colours to produce an artificial imitation of the insect on tracing paper. Using faint washes of black colour for the 'leaf pattern,' and opaque black varnish, *e.g.* brunswick black diluted with turpentine, for the black of the 'butterfly pattern' (or black paper cut out and stuck on). Perhaps a

large-scale drawing of this kind, arranged so that it could be lighted from in front, or from behind at pleasure would make an effective demonstration."

The examination of separate parts of the pattern through a window cut in a piece of card confirmed Lord Rayleigh's interpretation. The dark leaf markings crossing the light butterfly bands appeared distinctly darker when isolated than when seen as part of the whole pattern. At the same time their detail stood out more clearly, showing that the effect of transparency in these dark markings was due to a stippled disposition of the pigment rather than to transparency of the pigment itself. Lord Rayleigh also wrote that such darker parts of the "leaf pattern" might be reproduced by stippling "provided, of course, that they are not made too opaque on the average thereby." "I should think," he added, "that a very light average tint is all that is needed."

The wings of *Protogonius* mounted as a lantern slide were then projected on the screen, showing a greyish silhouette on which the "butterfly pattern" was barely visible. The difference between this appearance and that presented by the butterfly when viewed by transmitted light was very remarkable.

Following the suggestion of the President, Prof. Poulton had written to Lord Rayleigh concerning the cause of the above-mentioned difference. Lord Rayleigh had kindly replied on May 25 :—

"So far as I see, there is no reason to regard the method of observing the wings directly, or by lantern projection, as fundamentally different. The retina is the ultimate means of estimation in either case. The important difference is the immense loss of light resulting from projection on a white diffusing screen, which scatters light in all directions, and therefore immensely diminishes the amount to be seen in any one direction. The illumination is therefore very much fainter, and, according to all experience, this tends to the obliteration of faint contrasts. For instance, in photometry the problem is to equalise two patches of light placed side by side, and it is found that these have to be pretty bright if the criterion of equality is to be a sharp one. Sometimes it is impossible to

arrange for these to be bright, as for instance in the problem I am investigating of the faint auroral light of the night sky, and then it is found that a change of as much as 30 per cent. in one of the intensities is necessary in order to produce a definitely perceptible change, so as to upset the equality.

"So far as I can see, without experiment, this is probably the explanation. The ultimate causes are of course physiological."

Prof. Poulton was sure that Fellows would greatly appreciate Lord Rayleigh's kindness in explaining the phenomena and in permitting his explanation to appear in the Proceedings.

An Ascalaphid larva from Nyasaland.—Mr. C. L. Withycombe said :—" Prof. E. B. Poulton has kindly handed me for study a fine larva of an Ascalaphid sent to him by Dr. W. A. Lamborn, from Nyasaland. Two specimens were taken upon the bark of a Cedra rubber tree, on Nov. 26, 1919. Dr. Lamborn states that when a little chloroform was added to the box containing the larvae a small drop of fluid was exuded from the tip of each jaw. This was evidently saliva, which is poisonous, as well as of digestive function, in Neuropterous larvae.

"Both these larvae probably belong to the same species, although in the present state of our knowledge this cannot be determined. The larva is of typical Ascalaphid form, and from its size (having seen other full-fed Ascalaphid larvae) I should judge it to be in the last instar. The lateral segmental lobes of the body are well developed and flattened, closely adpressed to the surface on which the larva would rest.

"The most interesting feature of this larva is its coloration, which is clearly cryptic. On the bark of a tree it would no doubt be difficult to detect since it is mottled with greyish-white, black and brown. The body chitin colour is brown, but the macrotrichia or primary setae upon the body are either white or black. The black setae are all trumpet-shaped, with longitudinal, serrated striations, *i. e.* they are very similar to the dolichasters of *Psychopsis* larva (ref. Tillyard 1918). The white macrotrichia are of various forms. Those on the lateral lobes are either of elongate dolichasterine form, or else they may be furnished with soft, irregular, spine-like processes. A large number of white macrotrichia upon the back are

flattened as scales. These have been formed by the lateral compression of short dolichasters. All grades may be seen, from the typical dolichaster to the scale. Scales here are very similar to those of Lepidoptera, but they are less regular and less uniform. They are nearly all pectinate distally, but vary considerably in the length and disposition of these pectinations.

"The larva examined is now in the collection of the Hope Department at Oxford; another specimen is in the British Museum (Nat. Hist.)."

Drawings of some forms of scales were shown, together with photographs and some imagines of Ascalaphidae.

LIVING LARVAE OF PTEROCROCE STOREYI.—Mr. T. W. KIRKPATRICK exhibited living larvae of *Pterocroce storeyi* Withycombe (Nemoptera) from Wadi Digla, near Cairo; and distributed several to Fellows desirious of breeding them. These larvae are easy to breed if kept warm and dry, and will feed apparently on any smooth-skinned caterpillars. Their natural habitat is in caves or under overhanging rocks, the chief characteristics of the situations being the presence of fine limestone dust, the almost or quite complete absence of direct sunlight, a comparatively small range of temperature, and absence of direct moisture, *i. e.* rain or dew.

A RARE BEETLE FROM IRELAND.—Mr. O. E. JANSON exhibited specimens of *Leistus montanus* Steph., taken by him in July 1922 on the Knockmealdown Mountains, co. Waterford at an elevation of 1800 to 2100 feet, an unrecorded locality for this scarce mountain beetle.

Papers.

The following papers were read:—

(1) "On the Classification of the Carabidae," by Mr. T. G. SLOANE.

(2) "Observations on the Growth of the Larva of the Puss Moth (*Dicranura vinula* Fab.), by Mr. G. B. WALSH, B.Sc. (Communicated by Mr. E. C. Bedwell.)

(3) "On Thysaneura, Termitidae and Embiidae, collected in Mesopotamia and N. W. Persia by Mr. W. Edgar Evans, B.Sc., and Dr. P. A. Buxton," by F. SILVESTRI. (Communicated by Mr. K. J. Morton.)

(4) "On the Larva of *Pterocroce storeyi* Withycombe Nemopteridae)," by Dr. H. ELTRINGHAM.

(5) "Systematic Notes on the Crocini (Neopteridae) with descriptions of New Genera and Species," by Mr. C. L. WITHYCOMBE, M.Sc.

(6) "On the Mallophaga of the Shackleton-Rowatt Exhibition, 1921–1922," by Dr. J. WATERSTON.

Wednesday, June 6th, 1923.

The Rt. Hon. Lord ROTHSCHILD, F.R.S., etc., Vice-President, in the Chair.

Obituary.

The Chairman announced the death of Canon W. W. Fowler, a past President of the Society, and a vote of condolence with his relatives was passed.

Exhibitions.

Mr. J. F. GREEN exhibited and made remarks on some butterflies from the South of France, and said that he had been impressed with their numerous enemies there in the shape of birds and lizards.

BUTTERFLIES FROM KHARTOUM.—Mr. H. MACE, said that the butterflies exhibited were representative of a collection obtained by Mr. B. W. Whitfeild in the immediate vicinity of Khartoum since 1920, and made the following remarks:—

"Special interest attaches to specimens from the White Nile, because this forms the natural connection between the Ethiopian and Palaearctic regions, and, as I have suggested (Trans., 1922, p. 240), there is a tendency for species to travel down the river from the equatorial swamps, either by natural means, or through the unconscious agency of man, an increasing quantity of wood and fodder being constantly brought down to Khartoum.

"The valuable papers of the late Dr. Longstaff (Trans., 1913, p. 11, and 1916, p. 269), in which all records for the White Nile and the Nuba Hills have been carefully summarised, orm the basis of present study. In all, Dr. Longstaff recorded '5 species from the White Nile, 25 of which are from the

Khartoum district. In my paper I showed that Mr. Whitfeild had taken 27 species, 9 of which were new to Khartoum, though already recorded from further up the river. On the other hand, 7 of Longstaff's species were not taken by Whitfeild.

"Mr. Whitfeild has continued collecting since my paper was written and has taken several additional species, of which three are in Dr. Longstaff's list for the Khartoum district, one is in his White Nile list, and three are entirely new to the White Nile, or, at any rate, are absent from Longstaff's records. These fresh species are :—

"*Acraea neobule* Dbl., 1 ♀, July 1922. The genus is very scarce so far north and has not hitherto been found below Gebel En (Lat. 12.37).

"*Argiolaus ismenias* Klug, 1, July 1922. This is said to be plentiful in the Nuba Hills, but has not been recorded from the White Nile before.

"*Mylothris chloris*, 1 ♂, August 1922. A distinctly West African species, which does not appear in either of Longstaff's lists. I find in the British Museum, however, examples closely resembling this specimen, labelled "Bahr el Ghazal 1911." Apparently these have never been recorded, and evidently did not come under Dr. Longstaff's notice.

"*Teracolus chrysonome* Klug, common 1922, listed also by Longstaff.

"*T. eris* Klug, 1, July 1922. In the White Nile list, but noted as scarce (one only at Lat. 12.45). Mr. Whitfeild says he has seen others, but the species is hard to catch.

"*T. daira* Klug, several of both sexes, July 1922. Already recorded by Longstaff.

"*T. liagore* Klug, 1 ♂ of this scarce butterfly taken in July 1922. The only previous record is one taken at Ad Duwem (Lat. 14) by Dr. Longstaff.

"These records appear to confirm my view that the increasing settlement and cultivation of Khartoum is adding to its butterfly fauna.

"Swarms of *Pyrameis cardui* were seen flying over Sunt trees (a species of *Mimosa*). Webs covering these trees appear to be those of gregarious larvae, but as these were only noted from the steamer, closer inspection was impossible.

"In August 1922 Mr. Whitfeild spent a short time at Erkowit, a village loftily situated on the Red Sea hills some miles inland from Port Sudan. Unfortunately, it was very dry and butterflies were scarce. Chief interest attaches to specimens of a fine *Charaxes baringana* (?) Rothsch., of which half a dozen were taken, mostly in poor condition.

"The only other specimens were *Teracolus eupompe*, *T. vesta*, and *T. daira*, male. The last shows a distinct approach to *T. yerburyi*, which some authorities regard as the Arabian form of *T. daira*."

A REMARKABLE MALE OF PAPILIO DARDANUS BROWN.—Prof. POULTON said that when in 1921 he had been shown by his friend M. le Cerf the series of *P. dardanus* in the Paris Museum, he had noticed the peculiar colour of two W. African males with the label—"Forêt du Poste de Borabo, Haut Sassandra, Côte d'Ivoire: 1913: Lt. Granier." Both specimens were of a bright yellow colour, strongly contrasting with the pale tint of the well-known male. He exhibited to the meeting a third example of this aberration which had been received from Dr. V. G. L. Van Someren, who had bred it, on September 22, 1922, from the egg of a female taken at Nairobi. The family included thirteen other males of the normal colour. Nearly all of these males were of the *tibullus* Kirb. form with a strongly marked continuous black band on the hind-wing. Six of them emerged before the bright yellow male and seven after it. The female parent closely resembled the *hippocoonoides* Haase, form, and its female offspring included three resembling the parent and five of an ancestral *cenea* Stoll, form with all the pale markings creamy white and fluorescing in ultra violet light like the pale yellow of the male. Prof. Poulton hoped to examine the bright yellow male for fluorescence, and also to bring forward an account with illustrations of the splendid series of bred *dardanus* with their female parents from Nairobi which he had received from Dr. Van Someren and Canon St. Aubyn Rogers.

The name ab. *crocotus* * was proposed for the bright yellow

* From κροκωτός, kindly suggested by Mr. E. E. Genner, M.A., Fellow of Jesus College, Oxford, as the Greek word which most probably describes the colour.

male, although the two examples from the same forest on the Ivory Coast suggested that it may possibly exist as a local race in that locality.

It might be supposed that a deepening of tint had been produced by some accidental chemical action, caused, *e.g.*, by ammoniacal fumes or by long retention in a killing bottle; but Dr. Karl Jordan had agreed that this explanation was improbable.

Notes on Uganda insects.—Dr. G. D. Hale Carpenter exhibited a Stratiomyid fly, *Platyna hastata* F., collected in July 1921 in the Semliki valley to the west of the foot of Ruwenzori, and called attention to their habit of hovering together in the air and occasionally darting about like Syrphid flies. At certain moments the abdomen brilliantly reflects a white light. The insects exhibited were all males, as are all the known specimens in the National Collection, about 30 in number. The glistening appearance of the upper surface of the expanded flat abdomen is very striking.

The Pyrrhocorid bug, *Sericocoris zoraida* Kirk., in the same locality, was found on a tree trunk with its long proboscis apparently plunged into a rounded mossy excrescence on the bark. Further investigation, however, showed that this was the cocoon of an Apodid moth, the pupa of which the bug was sucking. This observation is of interest in regard to the enemies of insects protected by one means or another against the attacks of vertebrates. A large number of the larvae of Apodidae are well known to be provided with such unpleasantly stinging hairs and spines that it can hardly be doubted that their chief enemies cannot be vertebrates. It is therefore interesting to know at least one of the enemies which must destroy the superabundant larvae and pupae.

A Carabid beetle, *Drypta* sp. probably *D. cyanea* Casteln., the only example of which in the British Museum is labelled "West Coast." The specimen in question was taken running up a tree trunk in January 1923, near the far eastern border of Uganda.

Dr. G. D. H. Carpenter, who illustrated his remarks with lantern slides, also discussed *Pseudacraea eurytus* and its models in Eastern Uganda.

PHOTOGRAPHS OF THE HABITATS OF EGYPTIAN INSECTS.—Mr. C. B. WILLIAMS exhibited :—

Two larvae of a Nemopteron from Wady Digla near Cairo, Egypt, with a photograph of the Wady to give an idea of the type of country in which these insects are found.

A photograph of native bee-hives in Egypt, in the form of pipes made by rolling mud round basket work. The bees make their brood near the front end of the pipe and their comb near the back end.

A photograph of an incubator designed for testing the effect of different temperatures on insects. The machine consists of a copper pipe about seven feet long, with an ice bath at one end and a constant-temperature hot bath at the other. The heat flows along the pipe, which is well insulated, with the result that there is a more or less regular temperature gradient from one end of the pipe to the other. The pipe is pierced by a number of holes, and by inserting a tube in the hole at various positions any temperature required can be obtained.

Paper.

The following paper was read :—

"Reciprocal Mimicry between three indigenous Fijian Euploeine butterflies and an invading *Euploea*," by Prof. E. B. POULTON, D.Sc., F.R.S.

Prof. POULTON, in giving an account of this paper, showed a number of lantern slides illustrating the patterns of four species of *Euploea* in some of the eastern, western and intermediate islands of the Fijian group, respectively. A careful examination of the long series of specimens, with admirable data, which he owed to the kindness of Mr. H. W. Simmonds of the Agricultural Department, Suva, led to the conclusion that these islands were formerly the home of a dark-winged association with the pale submarginal markings, so common in Euploeas, either wanting or greatly reduced. Such a dark-winged association existed in New Guinea, the Solomon Islands, New Hebrides, etc., and still persisted in the eastern Fijian islands. In the western islands, however, including the two largest—Viti Levu and Vanua Levu—a pronounced pale submarginal pattern was present, due, Prof. Poulton

inferred, to the invasion of a strongly white-marked species, *Nipara helcita* Boisd., from the north-west. The development of this white pattern in the three other species was stronger in the females than the male, following the general rule of mimetic approach. It was suggested as probable that invasion took place in successive waves which gradually spread eastward through the islands, so that any effect of the dark-winged species upon the invader would be more quickly overpowered in the western islands than in the eastern, and, at the same time, the effect of the invader upon the indigenous forms increased. And, as a matter of fact, the four examples of *helcita* taken in the most eastern islands visited by Mr. Simmonds—Vanua Balavu (Bavatu)—all showed a reduction of the white markings. That this result was due to mimicry of the dark-winged association was confirmed by Mr. Simmonds' captures in the following two islands situated between Fiji and Samoa. In Fotuna I., *helcita* alone was taken, and all the examples were strongly white-marked. In Wallis I., where this species was captured with a larger number of a dark-winged *Euploea*, the white markings of all the *helcita* were greatly reduced.

Confirmation of the conclusion that the dark-winged association formerly spread throughout the Fijian group was afforded by the female forms of *Hypolimnas bolina* L. It was in every way probable that the Pacific forms of *bolina* were derived from the race with the red-marked *nerina* F., female, inhabiting Celebes, New Guinea, N. Australia, New Caledonia, New Hebrides, etc. Traces of the F.W. red patch of *nerina* were to be found in some females of *bolina* from probably every Pacific island where the species exists. In Fiji it gave rise to an extraordinary series of female forms, described as distinct species, but proved by Mr. G. F. Mathew, and recently on a large scale by Mr. H. W. Simmonds, who had bred seven families from the eggs of known female parents (Proceedings, 1923, p. x), to be the polymorphic females of *bolina*. Among them was a beautiful mimic of a dark-winged *Euploea* with a greatly reduced submarginal pattern, and this, occurring in islands where Euploeas are now more strongly white-marked, is evidence in favour of the previous existence

of darker models. There were also some indications that other female forms of *bolina* were incipient mimics of the recently developed white-marked models.

It was hoped that the arguments and conclusions of the paper would be made clear by abundant illustrations, showing the gradually developing pattern in the Euploeas as we passed from eastern to western islands, and also representing the forms of *H. bolina* bred by Mr. Simmonds.

Wednesday, October 3rd, 1923.

Mr. E. E. Green, President, in the Chair.

Gifts to the Society.

The Treasurer called attention to the ten new portraits added to the Society's collection and now hung on the walls of the Meeting Room, including one of the late Secretary, Mr. H. Rowland-Brown.

Miss Rowland-Brown, who was present as a visitor, addressed the Meeting, and expressed her thanks for the honour conferred on her late brother.

Russian Entomological Society.

The Secretary read a letter from the Russian Entomological Society thanking the Society for the financial help sent to Russian Entomologists in distressed circumstances.

Exhibitions.

Agriades bellargus ab. polonus Zell.—Mr. A. E. Tonge exhibited two specimens taken on the North Downs near Reigate on 24 June and 4 July, 1923, at the same spot. He stated that Tutt describes this as a natural hybrid between late *corydon* and early *bellargus* of the previous autumn and records the capture of one specimen at Cuxton, and several on the Continent. (See Brit. Lep., vol. x, pp. 323.)

Mr. N. D. Riley said that the specimens agreed with Zeller's type of *polonus*, and expressed the opinion that it was a hybrid.

Dr. Cockayne thought that the late Dr. Chapman had examined the androconia and had found them intermediate in character. Several other cases of the capture of this insect, chiefly on the Continent, were reported by Mr. Wheeler and others.

Rare British Beetles.—Mr. Donisthorpe exhibited the following very rare beetles :—2 *Arena octavii* Fauv., Hunstanton, July; 6 *Langelandia anophthalma* Aub., in seed potatoes, St. Peter's, July; 16 *Corticaria truncatella* Man., Hunstanton, July; and *Cryptophagus schmidti* Sturm., Wicken Fen, September, all taken by himself during the year, and made some remarks on their habits and previous records of their capture.

A remarkable Australian Oecophorid.—Mr. Bethune-Baker (on behalf of Dr. Jefferis Turner) showed imagines, pupae, larvae in spirit, and a piece of the nest in the termitarium with the old pupa cases, of *Neossiosynoeca scatophaga*. The larvae of this interesting Oecophorid live beneath the nests of the Golden-shouldered Parrot, a bird that excavates holes in termitaria or white-ant hills. The caterpillars feed on the excreta of the young birds. The exhibitor said that one of the specimens shown was one of the original paratypes, two others being bred examples.

From the piece of the termitarium two females emerged in September 1922. One of the cocoons was then opened and found to contain an unchanged larva, which repaired the incision. Opening it again in November Dr. Turner was surprised to find the larva still unchanged. After six months, moths again emerged, and between March and the beginning of April about a score of both sexes did so.

At Dr. Turner's request the three imagines are being deposited in the Natural History Department of the British Museum, the type having been presented to the Australian Museum, Sydney.

A Sawfly with the tarsi, etc., of one leg duplicated.—The Rev. F. D. Morice exhibited on behalf of a correspondent (Mr. J. W. Saunt of Coventry) a teratological specimen of the common sawfly, *Pachyprotasis rapae* L., ♀, in which the right hind-leg has its tibia dilated at its apex, but not otherwise abnormal. The tarsi of that leg are, however, completely

duplicated (fig. 1); and at the apex of the tibia, instead of the normal pair of calcaria, there are—(1) one such pair, (2) another pair fused together except at their apices, and (3) a single (unpaired) calcar, making five in all.

Mr. Saunt had informed the exhibitor that the specimen was given to him by Dr. Newton of Coventry.

Lepidopterous cocoons from South America.—Dr. K. Jordan exhibited two pensile cocoons and the imago of a South American moth obtained at Pará by the Rev. A. M. Moss, F.E.S. The cocoons are similar to the one described and figured by Bates in "The Naturalist on the River

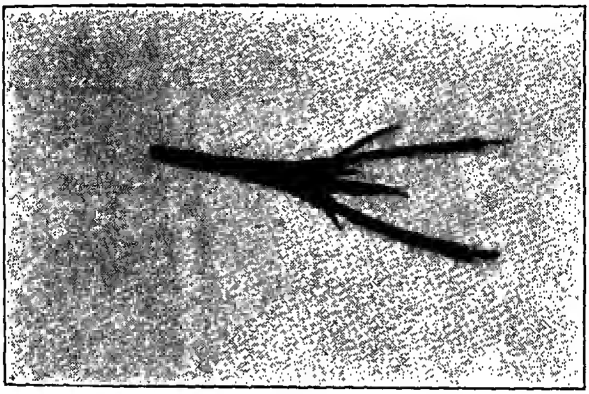


Fig. 1.

Amazons," being of a beautiful violet-red colour and suspended by threads 7 and 8 inches long. The thread, which is fastened to the edge of a leaf, is composed of a large number of filaments glued together, and its surface is not smooth, but is rendered rough by numerous clavate projections, which, on an average, are about as long as the diameter of the thread, some being shorter and some longer. These processes project at right angles, and, though not quite regular in arrangement, are almost evenly distributed over the whole length of the thread. They probably serve as protection against prowling insect enemies, and it was suggested at the Meeting by the President that the incrassate tips of the projections might be viscous for a sufficient length of time

to produce this result. The species which spins this cocoon belongs to the genus *Urodus*, Hyponomeutidae (cf. Durrant, P.Z.S., 1897, p. 114).

Prof. POULTON expressed the opinion that the projections described on the thread might serve as a protection against ants.

AN ABNORMAL ZYGAENA FILIPENDULAE.—Mr. T. H. L. GROSVENOR exhibited an example of *Zygaena filipendulae*, ♂, taken at Royston, Herts, August 1923, the left side being normal but the right side having the hind-wing replaced by a second primary, both wings being fully developed and the costa of both slightly concave.

VARIETIES OF ARCTIA VILLICA.—Mr. H. M. EDELSTEN exhibited a series of *Arctia villica* bred from ova laid by a ♀ from Haywards Heath, Sussex, some of the specimens being asymmetrical, one with left hind-wing smoky, another with right hind-wing smoky, and a third with right fore-wing all black except for two apical white spots.

A REMARKABLE LEPIDOPTEROUS LEAF-MINE FROM S. NIGERIA.—Prof. POULTON exhibited a mined leaf sent by Lt. H. B. Waters from the Agricultural Dept., Moor Plantation, near Ibadan. Mr. J. H. Durrant, who had examined the specimen, considered that the mining larva, of which two had attacked the leaf, certainly belonged to the Tineina and was allied to *Nepticula* or more probably *Lyonetia*. The remarkable and beautiful appearance of the two mines is shown of the natural size in the accompanying text-figure from a photograph kindly taken by Mr. Hugh Main (fig. 2). It will be seen that the mines terminate one on each side of the midrib, at the base of the leaf. It was hoped that Lt. Waters would breed the moth from similar mines so that it can be determined, and also forward material from which the plant can be named.

AGRIADES HYBR. POLONUS, ABERRANT POLYOMMATUS EROS, AND BRED. AGRIADES HISPANA.—The Rev. G. WHEELER exhibited a specimen apparently of the hybrid *Agriades polonus* Zell., taken this year at Ober-Bozen, and also for comparison one of the five undoubted *polonus* which he took at Assisi in 1909. The upperside of both insects was midway between *A. corydon* and *A. thetis* in colouring, but the under-

side was nearer to that of *A. corydon*. Both insects were taken among *A. thetis* at a time when the other species had not yet appeared.

He also exhibited an aberration of *Polyommatus eros* Ochs., rather above the average in size, the colour of the upperside of which was almost that of *Albulina pheretes* Hb., taken at Celerina in the Upper Engadine on 7th July this year, a similar example from E. Prussia being recorded by Spuler (Schm. Eur. i., p. 64).

Mr. Wheeler also exhibited on behalf of Mr. Prideaux a ♂ and ♀ of the second brood of *Agriades hispana* H.-S. (the double-brooded species so long confounded with *A. corydon*), reared from ova sent by him to Mr. Prideaux from Florence

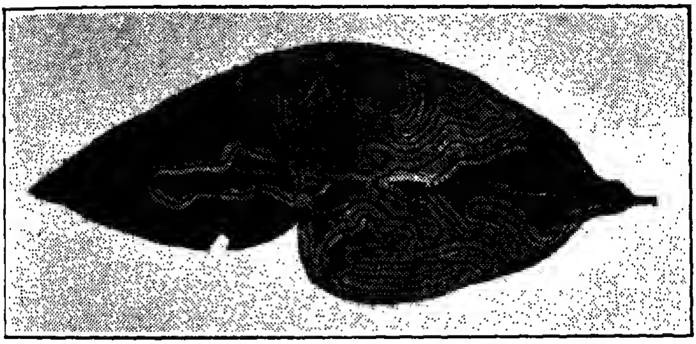


Fig. 2.

in May. He observed that he was doubtful as to the correctness of the name, and also remarked that he believed the species had not previously been bred from the egg. He exhibited specimens of the first brood including the ♀ parent of Mr. Prideaux's specimens, and pointed out the differences, especially on the underside, by which the two species may be readily distinguished.

The following are Mr. Prideaux's notes on the early stages:—

"Seven eggs of this species were sent to me on 23rd May last, having been laid on 17th–18th May previously, by a female obtained from Florence, by Rev. Geo. Wheeler. They were laid on stem, leaflets and flowers of what appeared to be *Hippocrepis comosa*, on which the larvae were subsequently

reared. The eggs were indistinguishable to me, microscopically, from those of *A. corydon*. As it was expected that a second brood of the butterflies would be produced from these eggs, and having regard to the prolonged wintry weather in May and June, the eggs, and later on the larvae, were kept in a warmed room. The first egg hatched on 14th June, the next four on 19th, 20th, 21st June; the last two appeared to be infertile.

"In its earlier stages the larva rests along the midrib of a leaflet of the food-plant; later on they preferred to hide, when not feeding, under moss or leaves. The upper surface and soft tissues of the leaflets are first eaten, the lower epidermis remaining intact; a little later, however, the leaves were forsaken for the flowers, which were preferred as long as they were obtainable. The young larvae, however, reverted to a leaflet when undergoing a moult.

"There were four larval moults in all. One of the five larvae was missing at an early stage; of the remaining four, two died when half to three-quarters grown. In habits and appearance they closely resembled those of *A. corydon*, but I had none of the latter species at hand with which to compare them more closely.

"Pupation of the first larva took place about 15th August, of the second on 21st August. The pupa was fastened under moss to the bottom of the cage by a few loose threads, to which there was no cremastral attachment. The first butterfly, a male, emerged on 16th September, and the second, a female, the next day."

Papers.

The following papers were read:—

1. "On Scent Organs in the Genus *Hydroptila* (Trichoptera)," by Mr. MARTIN E. MOSELY.

2. "Coleoptera from the Seychelles, Lampyridae, Helodidae, Cantharidae, Melyridae and supplement to Cleridae," by Mr. G. C. CHAMPION.

3. "The Dragonflies (Order Odonata) of Fiji, with special reference to a collection made by Mr. H. W. Simmonds, F.E.S., in the Island of Viti-Levu," by Dr. R. J. TILLYARD.

Wednesday, October 17th, 1923.

Mr. E. E. GREEN, President, in the Chair.

Obituary.

The Chairman announced the death of the Hon. N. C. ROTHSCHILD, a former President of the Society, and a vote of condolence with his relatives was passed.

A vote of condolence with Mr. G. T. BETHUNE-BAKER on the death of Mrs. BETHUNE-BAKER was also passed.

Election of Fellows.

The following were elected Fellows of the Society :—Mr. S. N. CHATTERJEE, Forest Research Inst., Dehra Dun, U.P., India; Mr. J. H. HUTCHINSON, M.A., Challoner House, Cockermouth; and Mr. G. L. R. HANCOCK, Trinity College, Cambridge.

Exhibits.

HEAT, DROUGHT AND SOME DESERT INSECTS.—Mr. P. A. BUXTON made some remarks, illustrated by diagrams, on interesting investigations recently carried out by him in Palestine on the temperature of the surface of deserts and of the insects themselves that live on the hot surface.

INSECTS FOUND IN BATS' DUNG.—Dr. N. H. JOY exhibited the following insects found in bats' dung in a house near Reading :—

A flea, *Ischnopsyllus octactenus*; the bugs, *Oecacus hirundinis* and *Cimex dissimilis*; a tick, *Argas vespertilionis*; the beetles, *Attagenus pellio*, *Tenebrio molitor*, a larva of *Anthrenus* sp.? and *Gyrophaena lucidula*; a moth, *Borkhausenia pseudospretella*; and a spider.

He also exhibited some Coleoptera taken at Windsor associated with the ant, *Acanthomyops brunneus* Latr., including *Euryusa laticollis* Hew., and *E. sinuata* Er., new to Britain; also *Cryptophagus pubescens* Strm., with nearly black elytra, taken in a hornet's nest and *Xestobium tessellatum* F., and *Dryocoetes villosus* F., making galleries in old oaks.

HYBRID AND OTHER LYCAENIDAE.—Mr. L. W. NEWMAN exhibited a possible hybrid, between *Polyommatus thetis* and *P. icarus* taken June 1923 in Kent, with the shape of the wings and underside that of *icarus* and the upperside scaling of *thetis*, and with a total absence of grey or black scales in the short part of the fringes and a very pronounced row of black spots on the hind-wings as in *P. thetis conjunctaria*; also a second, very similar specimen, but having no black spots, taken Sept. 1923 in Kent, and two specimens in which the general build is that of *thetis* and the uppersides are *thetis* scaling, but in which the underside favours *icarus* to a certain extent.

He also exhibited an example of *Polyommatus coridon*, the underside of which has all four wings marked quite differently, and a gynandromorph of the same species.

ABNORMAL FORMS OF ZYGAENA.—Mr. T. H. L. GROSVENOR exhibited a number of structurally abnormal specimens of Zygaenidae including examples of *Z. lonicerae*, *Z. trifolii* and *Z. filipendulae*.

A VARIETY OF CLEORA GLABRARIA.—Mr. A. E. TONGE exhibited a ♀ of *Cleora glabraria*, taken in the New Forest in July 1923, with the usual black markings so much extended and suffused as entirely to alter the appearance of the insect.

A REMARKABLE FORM OF PARNASSIUS APOLLO.—The Rev. G. WHEELER exhibited specimens of *Parnassius apollo*, the underside of the thorax and abdomen being covered with bright yellow hair; all specimens from the isolated "island" on which the cemetery chapel of Celerina, Upper Engadine, is built were of this form this year, whilst those from the neighbouring localities were all of the usual greyish white coloration.

LIVING EXAMPLES OF PYTHO DEPRESSUS.—Mr. P. HARWOOD exhibited living specimens of the Heteromerous beetle, *Pytho depressus*, obtained from larvae found under pine bark near Boat of Garten, Inverness-shire, in July 1923, together with a larva of the same species.

FORMOSAN AND S. AMERICAN LEPIDOPTERA.—Mr. A. DICKSEE exhibited the following Lepidoptera from Formosa and South America:—1. *Eriboea narcaea megadhuta*, only three specimens received and all different. One has a com-

plete row of small white spots outside the normal row on the front-wing. Another has the plain black band of the hind-wing broken up into a narrow band and a row of black spots. In the third case, the black streak extending from the lower end of the cell of the front-wing to the margin, does not reach the margin, but is cut off with a square end like the various forms of *Eudamippus*.

2. A series of *Calinaga buddha formosana*, including the very rare female.

3. A ♀ of *Agrias aedon* from Colombia.

4. A ♀ *Castnia* which he believed to be the hitherto unknown ♀ of *C. fournieri*, together with a ♂ of that species and a ♀ *C. staudingeri*. He pointed out that Dr. Strand has suggested that *C. staudingeri* is the female of *C. inca*, but as the ground-colour of the hind-wing of *C. inca* is unicolorous and as *C. staudingeri* shades from orange through yellow to white, and the black streak on the hind-wing is also different, the specimen exhibited, which as regards the hind-wing exactly resembles the ♂ of *C. fournieri*, must be its female.

A LARGE FAMILY OF HYPOLIMNAS (EURALIA) DUBIA BEAUV., FORM WAHLBERGI WALLGR., BRED FROM A CAPTURED FEMALE OF THE SAME FORM AT DURBAN.—Prof. POULTON exhibited eleven out of thirty specimens from a uniform family of the *wahlbergi* form kindly sent to him by Mr. E. E. Platt, together with the following account of the circumstances under which they were bred :—

"403, *Essenwood Road*,
"*Durban*,
"*June* 25, 1923.

"The family originated from a *wahlbergi* ♀ captured by a friend of mine, Mr. King, who brought it to me on Mar. 31. Ova were laid from April 1 to 5, on which date I liberated the parent, who had apparently not finished laying.

"When the larvae were in 2nd and 3rd skin I handed over half of them to Mr. King. At this time there were altogether over 350 small larvae.

"Mr. King had to go up-country just as they were beginning to pupate, and gave his lot to Mr. Leigh and Mr. Harold Millar.

"Mr. Leigh tells me he bred 92 good specimens, and estimates about 8 were crippled, while Mr. Millar bred 15.

"My results were as follows:—

	♂	♀
May 18	4	—
19	4	—
20	4	—
21	4	1
22	4	6
23	7	6
24	12	6
25	8	7
26	11	11
27	4	3
28	3	2
29	6	4
30	18	15
31	4	7
June 1	5	6
2	1	4
3	—	1
	99	79 = 178

"This makes a grand total of 293—all *wahlbergi*.

"You will be sorry to hear that my attempts to induce a pairing were unsuccessful. This is the first time I have bred the species since 1914, when I sent you the results. And, as you will remember, they threw but little light on the Mendelian standing of the form in S. Africa."

Mr. Platt's record showed, as in his 1913–14 family (Proc. Ent. Soc. Lond., 1914, p. lxx), a preponderance of male emergences at the beginning and of female at the end. His results were consistent with the conclusion previously suggested (*ibid.*, pp. lxx, lxxi) that the *wahlbergi* form is a Mendelian recessive and *mima* dominant, and that the female of the *wahlbergi* form, taken *in coitû* with a *wahlbergi* male on Dec. 28, 1913, had previously paired with a male *mima*. The present family was almost certainly derived from *wahlbergi* parents only.

Considering the close similarity of the *wahlbergi* form to the western *anthedon* Dbl., and of *mima* Trim., to the western

dubius Beauv., it was in the highest degree unlikely that the Mendelian relationships were different, and Mr. W. A. Lamborn's bred families had shown many years ago that the *anthedon* form was recessive and *dubius* dominant (*ibid.*, 1912, p. iv). Although no other conclusion could be drawn from the facts which we owed to Mr. Lamborn it was very desirable that the Mendelian interpretation should be confirmed by breeding a second generation, although it was to be feared from Mr. Platt's experience that the attempt would be difficult.

A HAWK ATTACKING PAPILIO REX OBERTH., AT NAIROBI.—Prof. POULTON exhibited a male *rex* with the male of its Danaine model *Tirumala* (*Melinda*) *formosa* Godm., taken on the same day, January 14, 1919, at Nairobi, by Canon St. Aubyn Rogers, and read the following note written July 28, 1923, by Dr. V. G. L. Van Someren :—

"I rescued a *P. rex* the other day from a small species of hawk—*Accipiter minullus tropicalis* Reichenow—rather strange, particularly as *M. formosa* swarmed in the patch of flowers where *rex* was taken."

A REMARKABLE VARIETY OF THE DRY-SEASON FORM OF PRECIS OCTAVIA SESAMUS TRIM. FROM NAIROBI.—Prof. POULTON exhibited a variety of the *sesamus* form taken in June 1919 at Nairobi by Dr. V. G. L. Van Someren. The band, normally red, which runs through both wings parallel with their outer margins, was white in this insect. Although the other pigments appeared to be normally developed, the butterfly was an albino as regards the red. Dr. Van Someren remembered taking "the insect just as it is, and, in exactly the same spot, within ten minutes captured two beautiful intermediates between the wet and dry forms." Prof. Poulton said he had never before seen such a variety which he thought must be extremely rare, if not unique.

LARVAL ASCALAPHIDAE ON LICHEN-COVERED BARK AND A GREEN-PAINTED POST AT NAIROBI.—Prof. POULTON exhibited photographs of two Ascalaphid larvae which appeared to be allied to the one described by Mr. C. L. Withycombe in Proc. Ent. Soc. Lond., 1923, p. xliii, and taken by Mr. W. A. Lamborn on lichen in Nyasaland. It was much to be hoped that Dr.

V. G. L. Van Someren would succeed in breeding the perfect insects. The conditions under which the larvae occurred were explained in the following letter, dated September 12, 1923, received from Dr. Van Someren :—

"Enclosed is a photograph of two Ascalaphidae,? of the same species: the upper one is greyish like the pale lichen, the other rather smoother and greenish. The former was taken on a lichen-covered fig tree, the latter on a green-painted post on which the paint had weathered and had become dull and powdery. Both insects greatly resembled their immediate surroundings. I have both alive and am feeding them on flies and aphids. I send this photograph in view of the interest taken in the Nemoptera at the recent meetings of the Society. These insects can starve for an extraordinarily long time: the chances of prey coming their way must be very few."

BUTTERFLIES FROM THE SEMLIKI VALLEY, WESTERN UGANDA.—Dr. G. D. HALE CARPENTER exhibited specimens from a collection made in July 1921 by himself and Major C. A. Wiggins, C.M.G. The expenses of the expedition were defrayed from a fund for the study of evolution presented to the University of Oxford in the name of Professor E. B. Poulton by his friend Professor James Mark Baldwin.

The precise locality was the Buamba Forest in that part of the Semliki Valley which lies west of the north end of Ruwenzori and in British Territory, viz. the Toro district of Uganda. The elevation was about 3,000 feet and the position about 30° 5′ E. and 0° 45′ N. The forest represents the extreme eastern edge of the great Congo forest which stretches westward to the sea, and is of much interest in that it affords a passage between the typical conditions in that great West African sub-region and the open country and scattered forests of Uganda, the latter being remains of the forest that almost certainly stretched at one time continuously to the western border of L. Victoria or perhaps further.

Dr. S. A. Neave had collected in the same locality in 1911, and Dr. Carpenter also referred to his collection and regretted that time had not allowed him to make a statistical comparison between it and larger collections either to the east or west.

The present collection showed very definitely that biological transition from a western to an eastern appearance took place just where geography demanded it, and that forms intermediate between the two extremes were particularly common in Buamba. A series of *Pseudopontia paradoxa* Feld., from this locality had been previously shown (Proc. Ent. Soc., Lond., 1922, pp. lvi–lxvii). *Acraea alciope* Hew., *Planema epaea* Cr., and *Papilio cynorta* F., which extend from the West Coast into Uganda, their extreme forms of females having quite different appearances, were taken in the Buamba Valley in interesting forms. The female of *Acraea alciope* appeared in both the form *tella* Eltr. (*alicia* Gr.-Sm.) transitional towards the West Coast female, *macarina* Butl., and the eastern Uganda and Cameroon form *aurivillii* Staud., one specimen of each being taken, but also a third specimen very beautifully intermediate between the two. Dr. Neave's collection contained a preponderance of western Uganda forms: he took twenty typical *tella* (*alicia*), and only one *aurivillii*, while there were eleven forms transitional between these two. The typical western black and white female of *Planema epaea* did not appear either in Neave's collection or in the one now under discussion. In the Buamba Valley the forms are either the typically eastern *paragea* or transitional stages much nearer to *paragea* E.M. Sh., than to *epaea*; in the present collection is one *paragea* slightly transitional towards the western *epaea* and one about midway between the two forms. Neave took one specimen only, a typical *paragea*. On the other hand, in each collection is a male of the typically cow-red western form *epaea!* *

Papilio cynorta, the female of which is so closely connected in coloration with the species just mentioned, is equally interesting. The present collection contains only one female exactly midway between the western black and white form and the eastern form *peculiaris* Neave, with cream-yellow markings contracted in area. The only specimen taken by Neave was of the same appearance, but in other forests on the Uganda-

* These facts are of much interest, indicating that the transformation of *epaea* into *paragea* occurred first in the female and was far advanced before any change took place (probably by transference from the female) in the male.—E.B.P.

Congo border the typical *peculiaris* appears, and none of the truly western black and white form mimetic of the true *epaea.* Yet at another locality much further to the east, viz. the edge of the Tero Forest on the Buddu (west) coast of L. Victoria,* the writer in 1915 found *P. cynorta* extremely abundant, but *all* were of the typical western black and white form while the 15 *Planema epaea* were all of the eastern form *paragea,* one being very slightly and another even more slightly transitional to the black and white western form. These differences at different meeting-points of west and east are most interesting when the two extremes are considered.

A male and female of *Planema macaria hemileuca* Jord., an eastern form of a truly western species, were taken during the time now under consideration.

Among the Nymphalines may also be noted the same mixture of east and west. *Hypolimnas dubia* Beauv., is particularly interesting; it was quite abundant, and 26 specimens were taken; 6 were the typical western *H. anthedon* Dbl., mimicking *Amauris niavius* L., of which 6 specimens were taken, all typically western with the white areas small in comparison with the eastern form.

Ten of the *dubia* come under the heading of form *damoclina* Trim., in which the white area of the hind-wing is much contracted, so that the form resembles the western *Amauris hecate* Butl., of which one was taken. There are also 8 of a form like the last, but with the hind-wing area yellow, so that this is transitional to the southern and eastern form *mima* Trim., mimicking *Amauris echeria* Stoll. Of the 2 remaining *dubia,* one is the common western form mimicking *Amauris damocles psyttalea* Plötz; and the other a form intermediate between *dubia* and *anthedon.*

Hypolimnas dinarcha Hew., appears in a very rare form *bartteloti* Gr.-Sm., with the marginal spots absent from the fore-wing. According to Aurivillius in Seitz, this form is truly western, being only known from the dark forests of the Congo interior.

The genus *Pseudacraea* was poorly represented at the time

* The locality, which lies in 1° 10′ S., 31° 30′ E., is described in detail in Proc. Ent. Soc. Lond., 1916, p. cx.

of our visit, but a single *boisduvali* Dbl., of the western form was taken.

Precis terea showed a nice transition: out of 3 specimens taken one was of the western form *terea* Dru., one of the southern and eastern form *elgiva* Hew., and one beautifully intermediate between the two.

Aterica galene Brown, was seen in abundance, but as usual was very difficult to catch. The 4 females secured were not truly western, as the pale area of the hind-wing instead of being white is yellow bordered with orange: hence these specimens are transitional to the eastern form *theophana* Hpffr., in which the hind-wing has the basal area deep orange, so that the form is no longer mimetic of *Amauris* as is the western form with white base to the hind-wing.*

Charaxes show points of interest, the rare *C. kahldeni* Hom., was found to be not uncommon, and 5 specimens of the pale green wet-season form were taken. Its distribution is given by Aurivillius as "Cameroons to Angola," so that its discovery in the Buamba Valley much increases its known range. The common, closely allied, *zoolina* Westw., was not taken.

Another rare species is *C. zelica* Butl., of which one was taken, while a second eluded capture. Aurivillius says of this, like the last, "only certainly known from the Cameroons and Angola," but there is a specimen in the collection of the Govt. Entomologist of Uganda from the Mabira Forest between Kampala and Jinja, and Dr. Van Someren has taken it at Jinja so that its range extends into the heart of Uganda.† Another rare species taken in the Buamba Valley is *imperialis* Butl. The presence of *Palla ussheri* Butl., gives a very western appearance to the Buamba fauna, but this too extends further eastward like *C. zelica*.

* The form with white hind-wing and that with yellow hind-wing are by no means confined respectively to West and East Africa, since the yellow form appears on the West Coast, and I have seen a white form from the S.E. corner of the Congo or the adjoining part of N. Rhodesia. But a cursory examination of the series at the Hope Dept. shows that a greater proportion of the western specimens have the hind-wing more or less white than in the east, and that the really white hind-wing does not seem to occur in the extreme east. But detailed examination of a long series is required on this point.

† Mr. Joicey has also recorded its occurrence in various parts of Uganda (Bulletin of the Hill Museum, vol. i, no. 1, p. 69).

Euphaedra and its allies were present in great abundance and were a very characteristic feature of the fauna at the time of our visit; these butterflies are typical of the great forests of western tropical Africa. Of particular interest was a specimen of the white variety of *Euphaedra eleus* Dru. It seems quite possible that, if this well-formed variety which looks as if it were a "sport," should become established, it might well become an addition to the ranks of mimics of *Amauris niavius* L.: the only change would need to be a contraction in the size of the white areas of hind-wing and hind margin of fore-wing, for at present they correspond rather with the southern and eastern form of *niavius*, namely *dominicanus*, which does not occur in the western forests. The development of such mimicry would result in *eleus* following two models more widely separated systematically than the models of any other polymorphic species, for its normal model is a species of geometrid moth, *Aletis*.

The rare *Euphaedra edwardsi* Hoeven, was noted to show some peculiarities of flight, and two males and a female were taken. Aurivillius gives its distribution as "Ashanti to Dahomey."

The females of *Cymothoe theobene* Dbl. & Hew., were noted to be mostly of the typical pale form, but a single specimen in which the white areas are suffused with brown was captured, form *nigrescens* Poulton. It is very remarkable that the female of this abundant species is resembled by the females of two other Nymphalines, also taken in the Buamba Valley. One is *Euryphura plautilla* Hew., a common species, belonging to the same subfamily Nymphalinae as defined by Aurivillius. The male of *E. plautilla* is much smaller than the female and of sombre brown, whereas the single pale brown and white female (near, but with pale areas less extensive than those of the ♀ form *albimargs* Talb.) on the upperside is remarkably like the female of *C. theobene*.

Much more remarkable is the likeness of the female of *Lachnoptera laodice* Cr. (= *iole* F.), which belongs to the subfamily Argynnidinae. The male is a light orange-brown butterfly, but the female is pale brown and white and closely resembles *C. theobene*; both males and females were taken

in light forest resulting from the overgrowth of old cultivated areas. Having for several years during the war collected the males of *Lachnoptera* drinking at pools in open grassy country together with *Atella* and other species, I was most interested to meet for the first time the female, occurring in forest. This difference in habitat between male and female of another species was particularly noticed in 1915 at the S.W. edge of the Tero Forest in Buddu on the western coast of L. Victoria. *Papilio ridleyanus* ♂ was found in abundance drinking at muddy pools in the open grassland outside the forest, but no females (Proc. Ent. Soc., 1915, pp. lxvii, lxxii, lxxv, lxxvi); the only female taken was in the forest.

Dr. Carpenter also exhibited a female of the rare and little known *Charaxes mixtus* identified by Lord Rothschild and Dr. Jordan, who described the species. It seems to be a mimic of the female of the common *Charaxes triridates* Cr. The description given of *mixtus* in Seitz is, judging by this specimen, erroneous, as Aurivillius describes the female of *mixtus* as "similar to the male and hence entirely different from *tiridates*." The specimen in question came from the locality already mentioned—the S.W. edge of the Tero Forest in Buddu, in 1915.

THE DISAPPEARANCE OF CRYPTIC PATTERNS DURING FLIGHT. —Dr. F. A. DIXEY exhibited some specimens of Pierines mounted between glass plates, to show the comparative disappearance of a cryptic pattern on the underside when viewed from beneath against a light background. He remarked on them as follows:—

"When Prof. Poulton brought to our notice the very interesting observation of Mr. Kaye relating to the replacement of the cryptic underside pattern by the mimetic upperside colouring in *Protogonius* as seen from beneath during flight, it occurred to me that it might be interesting to examine certain Pierine butterflies with a cryptic underside and an upperside of completely different character, in order to see whether in their case an analogous condition would be found to occur. Understanding from Prof. Poulton that this had not yet been tried and adopting his suggestion that I should look into the matter myself, I bethought me of *Eronia leda*

Doubl., which has in the dry season a strongly mottled underside, most probably cryptic in character; while the upperside is certainly not cryptic, though it may be questioned whether the conspicuous orange patch of the fore-wing is or is not aposematic. The specimens which I exhibit show, I think, that when held up to the light the cryptic mottling of the underside almost disappears, while the orange patch of the fore-wing, of which no trace would be seen in the resting position of the butterfly, shows through on the underside; so that in fact the underside, when light comes through it, as it would during flight, looks like a somewhat fainter version of the upperside, having lost for the time its cryptic character.

"Similarly, *Hebomoia glaucippe* Linn., which I also exhibit, has an underside which shows some individual variation, but which will be allowed in most instances to have a cryptic resemblance to a dead leaf. Held up to the light, the dead leaf becomes inconspicuous, and the underside, as in *E. leda*, presents a paler version of the upperside with its brilliant orange apical patch.

"Many years ago I made some preparations between glass slips of the wings of species of *Dismorphia*, which showed quite clearly that the underside, when light was sent through it, lost its own character and assumed that of the upperside. But it did not strike me at the time that this had any bionomic significance. With Mr. Kaye's observation, however, the case is altered, and the male specimens that I here exhibit of *Dismorphia praxinoe* Dbl., in their presumably cryptic underside and certainly mimetic upperside, offer, I think, a fair parallel to the very striking instance of *Protogonius*.

"It is by no means unusual, at any rate among Pierines, for features of the upperside to show through in this manner, and in many cases the phenomenon may not have any particular bionomic bearing, but when a markedly cryptic pattern almost or quite disappears under these conditions in favour of a conspicuous pattern, whether mimetic or otherwise, of the upperside, the fact can scarcely be held to be without significance. A cryptic underside, in obvious relation to the position of complete rest, can hardly be of advantage during flight; while it is clear that whatever advantage the upperside pattern

may confer will be equally enjoyed in these cases whether seen from above or below. This, I think, as already pointed out by Prof. Poulton, supplies the interpretation of such cases as *Protogonius* and those which I now exhibit.

"It is noticeable that in some instances, as in *D. praxinoe*, the female shows the mimetic pattern on both sides; there is thus no occasion for the disappearance of the underside pattern. In *Dismorphia leonora* Hew., which I also exhibit, both sexes show the transparency of the presumably cryptic underside very clearly."

Prof. Poulton exhibited and showed, projected upon the screen, the expanded wings of *Limenitis sibylla* L., and those of *Pyrameis atalanta* L., the right pair of the latter in the expanded, the left in the resting position. The exhibited specimens, which had been arranged and enclosed between glass plates by Mr. A. H. Hamm, provided an excellent demonstration of the transparency of the under surface sufficient to exhibit against the light, in the expanded position, the characteristic appearance of the whole upper surface of *sybilla* and that of the distal half of the fore-wing of *atalanta*. The transparency was however, as in *Protogonius* (Proc. Ent. Soc., 1923, p. xlii) insufficient to permit the upper surface patterns to appear, except very dimly, upon the screen.

Papers.

The following papers were read :—

1. "On the Early Stages of *Chrysiridia ripheus*," by Dr. H. Eltringham.

2. "On the Tympanic Organ in *Chrysiridia ripheus*," by Dr. H. Eltringham.

3. "On the Genitalia in *Sabatinca* and allied genera (Lepidoptera Homoneura) with some observations on the same structures in the Mecoptera," by Mr. A. Phillpott.

4. "On the African species of the Dynastid Genus *Heteronychus*," by Mr. R. W. Jack.

Wednesday, November 7th, 1923.

Mr. E. E. Green, F.Z.S., President, in the Chair.

Election of Fellows.

The following were elected Fellows of the Society:—Mr. G. Britten, Riwaka, Nelson, New Zealand; Mr. J. E. Campbell-Taylor, Mavisthorne, Southover, Lewes, Sussex; Mr. C. E. Clarke, c/o G. Howes, Esq., 452, George Street, Dunedin, New Zealand; Mr. D. A. Dewar, M.B., C.M., Altyre House, Stanley S.O., Co. Durham; Mr. A. C. Halliwell, St. Thomas's Hospital, Westminster; Mr. F. A. Mitchell-Hedges, F.Z.S., The Bridge House, Sandbanks, Parkstone, Dorset; Mr. Gordon Newland, 19, Bath Road, Bedford Park, W. 4; Miss Janet W. Roff, M.Sc., The University of Melbourne, Victoria, Australia; Mr. Sisir K. Sen, B.Sc., Agricultural Research Institute, Pusa, India; Mr. N. Temperley, Literary and Philosophical Society, Newcastle-on-Tyne; Mr. A. Twidle, N.S.A., The Rowans, Godstone Green, Surrey.

Exhibitions.

The Early stages of Platyrrhinus resinosus Scop.—Mr. H. Donisthorpe exhibited twelve specimens of *Platyrrhinus resinosus* Scop., 1763 (*latirostris* F., 1775), two of the larvae in spirit and pupal cells of this rather rare, very local, and very handsome beetle, and made the following remarks on them.

"Although it is 160 years since its original description and it has been known to occur in Britain for about 100 years, the fact remains that nothing was known about the earlier stages or life-history of this beetle before 1920. Stephens wrote, in 1831: 'It frequents the *Sphaeria fraxinea*, and is found upon the trunks of ash, alder, birch, etc.'; Fowler stated, in 1891: 'In fungi (*Sphaeria*) especially on old beech and ash trees'; and Reitter published, in 1916: 'The only European species lives in dry wood of beech and alder, in fungi (*Sphaeria, Corticinum cinereum*), and under bark.'

"In June 1920 I visited Long Ashton in Somerset (I may mention that with us this beetle is chiefly a West Country insect), where Mr. Gimingham had found it, and he very kindly took me to his locality, and we found four of the perfect insect on the fungus *Daldinia concentrica* on old ash trees. I also discovered in this fungus a number of its larva, which was then quite unknown, and I described and figured it (Ent. Record, xxxii, 157, Pl. IV, 1920).

"This year in June I again went to Long Ashton, but found that most of the trees had been cut down in Mr. Gimingham's locality, and none of the fungus occurred. However, after a considerable hunt I found more of the fungus on old ash trees in and near a wood some two miles away, and captured six of the perfect insects on it. I also brought home some of the fungus which was apparently quite whole and untouched, no holes or signs of where eggs had been laid being visible, and placed them in a large glass bowl. In August on examining this fungus it was found to be full of holes, and when broken up, to be entirely riddled and eaten away by the larvae, of which over a dozen were present. They must evidently move from one piece of fungus to another, and most of them died, not having enough to eat. Commander Walker kindly sent me some fresh fungus from near Oxford, and in this I bored holes and inserted the more vigorous larvae. Three eventually pupated, though one of these retained the larval head, and only two hatched—the one on September 2 and the other on October 7—but remained in their pupal cells excavated in the fungus, which I have brought for exhibition. They were very sluggish, very hard to kill, and would evidently have passed the winter in their cells.

"The life-history would appear to be briefly as follows: The parent beetle lays eggs in the fungus about May, or earlier; when these hatch the larvae feed inside the fungus until they have cleaned it out, and then pass to another, and when ready to pupate make a cell in the fungus. They hatch about September or October, and remain in their cells until next spring. Five or six months are taken up from the egg to the perfect state."

Factors controlling harvesting in an Ant.—Mr. P. A. Buxton described some observations made on a nest of *Aphenogastar barbara* L., in Jerusalem, Palestine. He concluded that activity was inhibited during summer at midday, except on days on which the relative humidity at midday exceeded 45 per cent.; probably the actual inhibiting factor was the infra-red rays of the solar spectrum. These heated the surface of the ground on ordinary days, to such an extent that the ants could not tolerate the temperature; on damper days the water vapour in the atmosphere cut out the infra-red rays, and permitted a modified degree of activity.

A New Papilio from the Philippines.—Mr. G. Talbot exhibited on behalf of Mr. J. J. Joicey an example of a *Papilio*, which although obviously allied to *xuthus* L., is so differentiated that it should be treated as a distinct species. The exhibitor said :—

" The specimen shown was obtained on the peak of Santo Tomas in the Benguet Province of Luzon. It is a very distinct form, and a description will be published in the Entomologist.

"*Papilio xuthus* is generally double-brooded except in Amurland. Dr. K. Jordan states in Seitz' "Macrolep," vol. ix, that the genitalia of the spring form differ distinctly, though not constantly from those of the summer form. Similar variation has been shown to occur in the spring and summer broods of the American *Papilio marcellus* Cram.

"*Papilio xuthus* is common in Japan, Korea, Formosa and neighbouring islands, and reaches as far as Hong-Kong, where it is scarce. It occurs westwards to the border of Tibet and to N.E. Burma on the border of Yunnan, also in Amurland. It is known also from the Bonin Is. and Guam. It is therefore not surprising to find this allied species in Luzon."

An unusual aberration of Coenonympha pamphilus.—Mr. E. Ernest Green exhibited an example of *Coenonympha pamphilus*, taken in the Delamere Forest (Chester), on July 11, 1922, in which the aberration consists of a patch of dusky scales surrounding the ocellus on the underside of the fore-wing and a larger dusky patch suffusing the lower angle of

the fore-wing. There is also a slight infuscation extending from the base of the fore-wing to the pale transverse bar near the ocellus. The coloration of the hind-wing (underside) is, perhaps, rather more intense than usual, but otherwise normal. The upperside is of the ab. *obsoleta* form, with the apical spot entirely absent.

FURTHER BIONOMIC NOTES ON LEPIDOPTERA AND OTHER INSECTS FROM THE FEDERATED MALAY STATES AND PENINSULAR SIAM BY CAPT. H. M. PENDLEBURY.—Prof. POULTON, in the absence of the author, communicated the following interesting observations sent to him by Capt. Pendlebury.

Since the notes on pp. xxxii–xxxiv of Proc. Ent. Soc. Lond. 1923, were written,* I have had further opportunities of studying the flight and resting attitudes of *Neorina lowii* Hew. and *Papilio helenus* L.

Whilst on a recent collecting trip, I happened to stay some days at Jor in the Batang Padang district (Perak). Jor Camp, as it is known, is a small cleared space (about five acres) in the midst of heavy jungle composed chiefly of bamboos, the mean altitude is 1,850 ft. It is used chiefly as a stopping-place for coolies, etc., carrying stores to surveying and other parties who are working on the main range.

Butterflies here are very numerous, *Terias* spp. predominating, though other Pierines, Papilios, Nymphalines and Lycaenidae are also abundant. Amongst the Papilios, I noticed *P. helenus helenus* L. and *P. iswara* White were very plentiful; generally to be found in groups of about six to ten lapping up moisture on the stones beside Jor stream. Whilst so occupied they kept their wings continually fluttering, as is the case with most of the other Papilios in this country whilst feeding. The moisture which is taken up apparently passes straight through the alimentary canal.

I noticed on several occasions examples of *P. helenus* resting during the daytime on the upperside of leaves with

* Capt. Pendlebury has pointed out that the locality Gunong Jerei in Kedah, mentioned in the table on p. xxxiii, was there wrongly spelled "Terei." He would also have preferred to omit the two sentences at the bottom of p. xxxiii and top of p. xxxiv, and substitute for them the fuller statement now published.—E.B.P.

their wings outspread, the fore-wing almost or completely covering the white patch on the hind-wing.'

I also found *N. lowii* in the jungle here (though I did not see any flying or feeding with *P. helenus*), and, when they rested, they invariably settled on the upperside of leaves with their wings outspread in a similar manner to *P. helenus*, though in this case the white patch on the fore-wing and a part of the white patch on the hind-wing was obvious; the white submarginal dots stood out quite clearly, the abdomen generally being raised above the plane of the wings. It is quite easy to distinguish these two species whilst in flight, though they might be confused by anyone who sees them for the first time.

Groups of butterflies composed chiefly of *Terias* spp. were to be found in and around Jor Camp, and also on stones by the stream, feeding at moist patches and filth. I noticed on several occasions that fowls kept in the camp would make a dash at one of these groups, snapping up any specimen they were able to pick out, and though I never happened to be near enough to see which specimen had been caught, I found mutilated remains of *Terias* after each of these onslaughts. It is quite conceivable that they may have been after a butterfly other than *Terias*, as there were generally several different species to be found in each group, and it was almost impossible to net a particular species without also including many *Terias*.

Papilio (*Ornithoptera*) *brookeanus albescens* Roths., also occurred very commonly at Jor, and were mostly in perfect condition. The males fly low, but the few females seen were all high up (thirty feet and more above ground). A few specimens were seen at 3,500 ft. and also at 5,000 ft. Fowls would not touch these insects either alive or dead.

The Zygaenid moth, referred to in Proc. Ent. Soc. Lond., 1923, p. xxxv, which appears to mimic *P. aristolochiae* L.,

* The late Dr. G. B. Longstaff has also recorded the fluttering of the wings during drinking and the concealment of the creamy patch on the hind-wing in the resting position of *P. helenus* ("Butterfly-hunting in Many Lands," London, 1912, pp. 383, 538–9). A specimen in the Hope Department, set under Dr. Longstaff's guidance, shows this interesting attitude. He also observed that the creamy patch is very conspicuous in flight (*ibid.*, p. 127).—E.B.P.

agrees well with the figure of *Histia rhodope tahanica* Jord. (Seitz, x, p. 22, pl. 3 *g*).

Examples of the mimicry of Hymenoptera by other insects.

1. *A Braconid model and Hemipterous mimic.*

I happened to be at Kuala Teku, Pahang, on November 25, 1922, and whilst walking near a felled tree I saw a Braconid * [*Platybracon amestris* Cam., ♀] fly off the trunk. This I secured, and immediately afterwards another insect, which I took to be a second Braconid of the same species, flew away from the same spot. I also managed to capture this, which on examination proved to be a Hemipterous insect, *Disphinctus sumatrator* Kirk. (Capsidae).

The remarkable similarity between the two made it impossible to distinguish them whilst flying; even in their pinned state they bear a noteworthy resemblance.

2. *Braconid models with Lepidopterous and Longicorn mimics.*

An Aegeriid day-flying moth † was taken near Jor Camp (Perak) in precisely the same locality as that in which several

* In the determination of the names of these examples of mimicry, which were exhibited to the meeting, I received the kind help of Mr. K. G. Blair, Mr. W. E. China, Mr. J. H. Durrant, Dr. C. J. Gahan, the Rev. F. D. Morice, Mr. B. Uvarov, and Dr. J. Waterston.—E.B.P.

† Unique in our collection.—H.M.P. [Mr. J. H. Durrant finds that the species belongs to a new genus and species which he has described as follows :—]

XENOSES, gn. n. (Drnt.).

(ξένος = strange + σής = moth).

Type : *Xenoses macropus* Drnt.

Antennae slightly dilated outwardly (tips broken). *Palpi* upcurved, terminal joint shorter than median, the latter scarcely roughened beneath. *Head* and *Thorax* smooth. *Forewings* elongate, narrow, costa depressed before apex, termen obliquely rounded: *neuration*, 11 veins; (7 + 8) coincident to costa. *Hindwings* broader than forewings, with transparent spaces: *neuration*, 3 and (4 + 5) connate. *Abdomen* smooth. *Legs :* hind tarsi about half as long again as the tibiae (about 1½); smoothly scaled, slightly tufted above the median spurs, hind tarsi slightly roughened beneath.

Apparently most nearly allied to *Macrotarsipus* Hmsn., but differing in the coincidence of FW. 7–8.

Xenoses macropus sp. n. (Drnt.).

Antennae black (ochreous where denuded—tips broken). *Palpi* orange. *Head* black, orange around the eyes. *Thorax* blue-black, patagia and tegulae orange, pectus orange. *Forewings* blue-black,

specimens of the Braconid model [*Iphiaulax* sp., nr. *pangaeus* Cam., ♀] were caught. Whilst flying, the hind-legs of the moth are stretched out behind, and bear a superficial resemblance to a long ovipositor such as is present in the model.

In connection with this or a nearly allied Braconid, I see that the late Mr. R. Shelford mentions and figures (P.Z.S., Nov. 4, 1902, p. 238, pl. 19) several species of *Oberea* which have the same system of coloration.

I happened to take several specimens of these *Oberea* whilst in Peninsular Siam (Khao Luang, March 1922) in which locality these Braconids also occurred. [A black species resembling *Iphiaulax* nr. *pangaeus* and dated March 13, Khao Luang, was sent by Capt. Pendlebury. Dr. Gahan identifies it as *Oberea curialis* Pasc. ♀.]

The difference in flight between *Oberea* and the Braconids was fairly well marked; whereas *Oberea* generally flies in a direct line, with head almost vertically above the body and antennae spread outwards, the Braconids fly in an undulating manner.

I also took another brown species of *Oberea* [*O. insoluta* Pasc., ♀] which bears a striking resemblance to another Braconid [*Iphiaulax astiochus* Cam., ♀] both in the same locality, Khao Luang, on March 19 and 14, respectively. The silvery patch on the ventral surface of the abdomen in these Longicorns, which is so conspicuous in the living insect, soon discolours in the dried specimen.

3. *A female Mutillid mimicked by a Clerid beetle.*

Although I happened only to take ♂ specimens of the *Mutilla* in the same locality (Pahang, Lubok Tamang, 3,500 ft.,

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orange at the base, cilia black; underside as above. *Exp. al.* 29 mm. *Hindwings* blue-black, cell and the space below it transparent, obliquely rounded from below cell, with a narrow triangular extension of black along cubitus and between 1*b*, 1*c*, and along the margin, also with an elongate ovate transparent spot immediately beyond discoidal between 5–6, and another, smaller, between 6–7. *Abdomen* blue-black. *Legs*: *anterior*, orange, base of tarsal joints spotted with black; *median*, orange, tarsi blue-black; *posterior*, blue-black, orange at bases of tibia and humerus.

Type: ♀ (8135 Drnt. Det. 1923).

Hab. PERAK, F.M.S.: Batang Padang, Jor Camp, 1,800 ft, 30. V. 1923 (*H. M. Pendlebury*). Unique.

June 1923) as the Clerid beetle,* *Tillicera javana* auctt., ? Spinola, I submit a ♀ specimen, viz. the model, taken at a similar altitude in another part of Pahang. [This species of *Mutilla* does not exist in the Brit. Mus. series.]

It is interesting to note how the lateral golden pubescence near the base of the elytra gives the appearance of a constriction in the beetle. This specimen was taken on a felled tree.

The *Mutilla* ♀♀ are to be found running about actively either on the ground or on leaves of low-growing vegetation and occasionally on young trees. The Clerid beetles are generally only to be found on tree-trunks (recently felled timber for preference), from which they readily take to flight when disturbed.

H.M.P., Sept. 1–5, 1923.

In addition to these interesting observations the following bionomic notes are quoted from Capt. Pendlebury's recent paper on "The Lepidoptera (Butterflies) taken in Nakon Sri Tamarat, Peninsular Siam" (Journ. Fed. Mal. States Museums, vol. xi, Pt. I, April, 1923, p. 21). The year in which the observations were made appears to have been accidentally omitted, but it was certainly 1922, which appears on specimens from some of the Siamese localities mentioned below. Some of the examples of mimicry have been previously recorded, but it is of the utmost importance to bring forward evidence that model and mimic frequent the same locality and that the resemblance holds during life and not merely in the cabinet.—E.B.P.

Capt. Pendlebury records, on p. 26, that he took on March 30, a Chalcosiine Zygaenid moth, which he has since identified as *Cyclosia pieroides* Walk. This insect, he considers, apparently mimics *Delias aglaia aglaia* L., occurring on the same day in the same locality, viz. Khao Luang (5,800 ft.).

The remaining bionomic notes refer to Nymphaline butterflies.

Cupha erymanthis lotis Sulz.—Observed in March in the same locality as the preceding insects, but at 2,000 ft. The

* Unique in our collection.—H.M.P.

butterflies were "seen flying in a cleared space near our camp in company with *Cirrochroa orissa orissa* Feld., to which they bore a superficial similarity whilst in flight" (p. 35).

Euripus halitherses pfeifferae Feld.—At Ban Lan Sah Kah, March 9. The female "whilst flying . . . resembled a Euploeine butterfly (*E. d. diocletianus* Fabr.)" (p. 41).

Kallima limborgi amplirufa Fruhst.—Two specimens taken about mid-day on Feb. 23, at Rhao Ram (1,200 ft.) were "flying about in heavy jungle and settled on green leaves in sunny patches with their wings wide open. Difficult to follow whilst flying through the broken lights, but when settled did not use their protective coloration on the underside of the wings in this case" (p. 38).

The same observation was made upon the common N. Indian species of this genus *K. inachis* Boisd. by the late H. J. Elwes, F.R.S., who appeared to consider that it was a fatal objection to the conclusion that the under surface is of procryptic value. But there are commonly wide differences between the attitudes of butterflies in the pauses between successive flights in bright sun and those adopted in the longer resting periods, in cloud or rain, at night or in the cool of dawn or evening, when the insects are always less alert and often quite torpid.

Prothoë franckii angelica Butl.—Four males were taken at Khao Ram (1,000–1,500 ft.), Feb. 28–March 2, and two at Khao Luang, 2,000 ft., March 20, and 1,500 ft., April 3, respectively.

"This species appears to be very local in its habits, only appearing in certain areas of heavy jungle where they fly—usually after mid-day—in shady places. Their flight is swift and jerky and their coloration makes them difficult to follow through the shady tracts they frequent. They settle very suddenly on trunks of trees with wings closed and almost invariably head downwards, the black lobe on the hind-wing underside apparently representing a 'false head.' The colouring of the underside of the wings is cryptic and this species is often difficult to see when resting on tree trunks discoloured with lichens. They seem to favour certain trees, and I have seen them coming back to the same tree two

or three times even, after having been disturbed" (pp. 41–42).

Charaxes durnfordi Dist.—Ten males of this rare or very local insect were taken at Khao Luang (2,000 ft.) between March 17 and April 3—" all in a small area of jungle, where they used to come and settle on the trunks of about three trees, which were within a radius of five yards of each other. I could find no sap exuding from the trees, and there was no apparent reason why these were selected. I caught one on the wing near this area, and the remainder were taken on the tree trunks where they settled with their wings closed and almost invariably head downwards; or on the leaves, in which case they usually were sunning themselves with their wings open.

" They fly very swiftly and their sombre colouring makes them difficult to discern in shady places. I never saw one much after mid-day or in any other part of the forest" (p. 42).

The remarkable snake-like appearance of an Ethiopian Sphinx larva in the terrifying attitude.—Prof. Poulton showed the photographs and the sketch referred to in the following extract from a letter written to him by Dr. V. G. L. Van Someren. Dr. Karl Jordan had kindly named the moth, from a drawing by Dr. Van Someren, as *Centroctena rutherfordi* Druce. The larva certainly appeared to be the most remarkable among the many snake-like larvae known up to the present time. The strong projection of the " eyes " in the terrifying attitude was especially striking. The depression of the caudal tubercle might be part of the general contraction of the body which causes the dilatation of the " eye "-bearing part and the projection of the " eye." The photograph also showed a snake-like undulation of the anterior part of the body in the terrifying attitude. The imago bred by Capt. W. A. Lamborn at Oni, 70 miles E. of Lagos, was also exhibited together with its pupa-case.

"*Nairobi, September* 5, 1923.

" I enclose two prints of photographs of a Sphingid larva in attitudes of repose and defence. It is really the best example

I have as yet seen of a larva mimicking a viper. You will note that the labial scales are particularly well reproduced.

"Unfortunately the photograph doesn't show it, but the two anterior legs, which are pinkish, are at times thrown forward to represent the forked tongue thus [sketch].

"Note also that the tubercle on the 11th segment is depressed when in the 'defence' attitude.

"The imago is a beautiful insect, one that I have not seen before."

Dr. H. ELTRINGHAM, who illustrated his remarks with lantern slides, gave some account of his paper on "The Early Stages of *Chrysiridia ripheus*, and the Tympanic Organ in that Moth."

Wednesday, November 21st, 1923.

Mr. E. E. GREEN, President, in the Chair.

The SECRETARY announced that the Council had nominated the following Officers and Council for 1924 :—

Officers.

President. E. E. GREEN, F.Z.S.
Treasurer. W. G. SHELDON, F.Z.S.
Secretaries {S. A. NEAVE, M.A., D.Sc., F.Z.S.
H. ELTRINGHAM, M.A., D.Sc., F.Z.S.
Librarian. H. J. TURNER.

Council.

E. C. BEDWELL, G. C. CHAMPION, F.Z.S., A.L.S., J. E. COLLIN, J. DAVIDSON, D.Sc., F.L.S., K. JORDAN, Ph.D., F. LAING, R. W. LLOYD, G. A. K. MARSHALL, C.M.G., D.Sc., F.R.S., W. G. F. NELSON, Prof. E. B. POULTON, M.A., D.Sc., F.R.S., W. RAIT-SMITH, H. WILLOUGHBY ELLIS, F.Z.S.

Election of Fellows.

The following were elected Fellows of the Society:— Mr. M. W. P. L. CAMERON, Imperial College of Science and Technology, South Kensington, S.W.; Mr. M. A. B. LEON,

Imperial College of Science and Technology, South Kensington, S.W.7; Mr. G. H. Marillier, 37, St. John's Wood Park, Hampstead, N.W.3; Mr. A. Valentine, Grand Hotel, Herne Bay, Kent; Lt.-Col. Richard M. West, M.D., D.S.O., O.B.E., Wootton Bridge, Isle of Wight.

Bequest to the Society.

The Treasurer announced that a legacy of £1,000 had been left to the Society by the late Hon. N. C. Rothschild.

Exhibitions.

Varieties of British Lepidoptera.—Mr. H. O. Holford exhibited a remarkable variety of *Triphaena pronuba*, taken in July 1923, with the fore-wings a very dark brown with a slight purple shade; the thorax the same colour and the abdomen a little lighter; the hind-wings smoky black, with a yellowish tinge at base and on inner margin, the usual black band showing as a darker mark; and the underside a uniform glossy brown with a pinkish tinge. Also a variety of *Camptogramma bilineata*, with dark markings on the costa of the left fore-wing, taken July 1921 at Peperharow near Godalming, Surrey.

Xenopsylla cheopis with a double Spermatheca.—Dr. K. Jordan exhibited a specimen of the rat-flea, *Xenopsylla cheopis*, with two spermathecae, and made the following remarks on it.

"Among the Siphonaptera (of which about 680 species are known) there are a few genera in which the female has two spermathecae, of equal size, each connected by a duct of its own with the single bursa copulatrix. In one Australian species (*Macropsylla hercules*) one spermatheca is about half the size of the other (cf. 'Ectoparasites,' i, 1921, p. 127). In all the other genera one spermatheca is present, and, in addition, as a rule a short second duct. We are justified in concluding that the ancestral fleas had two spermathecae, of which one is lost in the majority of the present-day genera. When I heard from Dr. Cragg, I.M.S., that he had found among some 30,000 specimens of *Xenopsylla cheopis* examined by him a female with two spermathecae of normal size, I was

much surprised and puzzled, as this find seemed to prove that a long-lost organ could reappear. Dr. Cragg very kindly agreed to send me the valuable specimen for N. C. Rothschild's collection, and I exhibit it here to-night. An examination of the specimen solves the puzzle. There are, indeed, two spermathecae, but it is not the double spermatheca of the ancestral type, the second organ is not the lost ancestral spermatheca. This female has two bursae copulatrices each connected with the oviduct, and from each bursa emanate two ducts, one leading to a spermatheca and the other being short and blind. We have here a mere duplication of the organs of copulation, a meristic variation explainable by the mechanics of ontogenetic development."

Salt (Chloride of Sodium) from human perspiration probably dissolved and absorbed by a Lycaenid butterfly.—Prof. Poulton said that it was of much interest that a Lycaenid butterfly was now proved by the following observations recorded by Mr. A. E. Wileman to act in the manner already witnessed on several occasions in the Hesperidae (Proc. Ent. Soc. Lond. 1916, p. lxxx; 1917, p. lxxvii, and the references mentioned in both communications). It would perhaps be remembered that the late Dr. Longstaff remarked that the observed behaviour proved that the Skippers could not by any possibility be looked upon as butterflies—a reproach which must now in justice be withdrawn. The fact that Lycaenidae assembled at spots where man or animals had urinated was well known (*ibid.*, 1917, p. lxxx) and quite consistent with the following observations:—

"One tropical day in February 1913, when I was collecting at a place named Klondike, a very wild locality situated at an altitude of 700 feet at the foot of the celebrated Benguet Trail, which leads to Baguio, the mountain-capital of the Philippine Islands in the Island of Luzon, I was accosted in a most friendly way by a butterfly which was evidently one of the Lycaenidae. Whilst I was standing still admiring the tangled profusion of luxuriant tropical vegetation around me, this butterfly settled on the back of my hand and immediately ejected from the anus a drop of colourless liquid. Then, to my great surprise, it turned

round and inserting its proboscis in the drop of liquid commenced to suck it up. It must have remained quite a few minutes on my hand engaged in this apparently pleasant, epicurean repast—of course I was too interested to disturb it—then it flew away. I have never had a similar experience before with any insect, and was quite amazed at the very extraordinary behaviour of this butterfly. Professor Poulton, however, assures me that it is a well-known habit of certain Hesperidae, and, at his request, I am placing on record the facts of this incident as they occurred. As this habit so far is apparently confined to the Hesperidae, it may be of interest to know that it is shared at any rate by *one* member of the Lycaenidae, as I am quite sure that the butterfly which accosted me was a 'blue,' not a Hesperid, but of what species I am unable to remember.—A. E. W. May 26, 1923."

THE LEAF-LIKE APPEARANCE OF A NEOTROPICAL TETTIGONIID (LOCUSTID) AND MOTH (THYRIDIDAE).—Prof. POULTON exhibited the brown leaf-like fore-wings of a male Tettigoniid and an entire specimen of another male with green leaf-like fore-wings, both from Costa Rica. Mr. B. P. Uvarov had kindly informed him that they belonged to the genus *Typophyllum*, but to no species represented in the British Museum. The two forms were evidently very closely allied and might be the dimorphic males of the same species. The striking fact about the specimens was the excavation of part of the wing margin in such a manner as to suggest that the apparent leaf had been eaten from the edge by a caterpillar. Such appearances were known in other species of *Typophyllum* and less strikingly in the allied genus *Pterochroza*; but the specimens exhibited to the meeting were far more remarkable than these others in the precision of the detailed resemblance to such an injury. In fact, when another example, in Mr. C. H. Lankester's Costa Rican collection, was first seen but not examined carefully by Prof. Poulton, he doubted whether the appearance was natural or caused by an actual injury. Mr. Lankester had, however, assured him that it was genuine, and promised to send specimens. The circumstances under which these two males which he had kindly sent were captured were explained in the following letters :—

"*Las Cóncavas,*
"*Cartago,*
"*Costa Rica, C.A.*
"*October* 3, 1922.

"The very morning we left for Peralta [September 11, 1922], and after shutting up the house, while waiting for the horses I pulled at some ferns growing in an orchid tub, and out jumped one of those curious leaf Katydids, a ♂. I put it in a tobacco box in the verandah to await our return, as it was destined for you, and unfortunately the ants got at it through the ventilation holes of the box and destroyed it.

"You may remember the species in question from the wings enclosed. You rather doubted the genuineness of that premorse area: well, though the ants have actually eaten part of the lower margin, the area in question was not touched in either wing. I still hope to get you a perfect specimen, though this is not a common species.

"*October* 11, 1922.

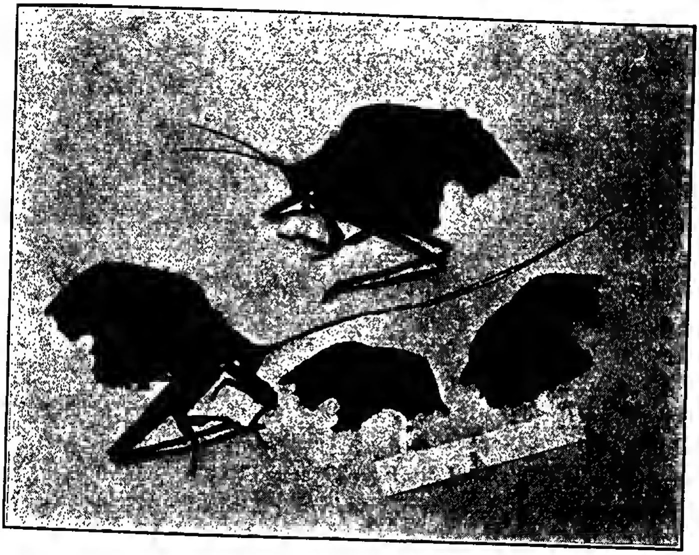
"Fortune has sent me another and perfect specimen of the procryptic Locustid I wrote to you about, only last week, and is herewith forwarded. This specimen, the third only of this sex I have found, is, as you see, green; the other two were both dull mauve-brown. Of the insect which I suspect to be the ♀ I have seen several in previous years and in other collections than my own: all were brown. In life the antennae are held straight and so close to each other that they appear to be one.

"Whether a change of colour occurs gradually during the life of the insect, or is owing to individual variation, I do not yet know. It will be seen that the colour of the specimen now sent is of a fading and not a bright living green.

"I took this insect [dated October 7] also at the base of an orchid, and pulled it out, thinking it was a fallen leaf."

The colour during life of the green specimen had been noted by Mr. Lankester as "deep chrysolite green"—XXXI of Prof. Ridgeway's scale. An interesting difference between the two forms was the fact that transparent areas representing

holes, and black patches representing cryptogamic growths, were present on the brown wings but not on the green. The apparent injury was in the apical $\frac{2}{5}$ of the lower margin in the position of rest, and its chief bay cut deeply into the "leaf," approaching but not reaching the "midrib," which with the "leaf-veining," was represented with extraordinary exactness. In all these respects the green and brown forms were very similar, but the bays were more deeply cut and the points between them more sharply projecting in the



brown form, especially along the apical section of the "injury." In the green form the margin of the "injury" was brown, as though decay-producing organisms had gained access through the freshly cut edge, and this brown margin extended inwards most deeply at the tip of the "leaf." In the brown form the edges of the chief bays were paler than the rest of the surface. The brown wings were smaller than the green, especially in their breadth, but the difference was no greater than that commonly found within the limits of the same species.

The accompanying figure, from a photograph kindly taken by Mr. Hugh Main, shows the green specimen on the left

and the brown fore-wings on the right, while the upper figure is that of the male in Mr. Lankester's collection. It is of a greenish brown shade and in size rather larger than the green male. Faint indications of the transparent windows seen in the brown wings are recognisable in similar positions on the upper figure.

Similar adaptations, in allied species, but none so striking as those seen in the exhibited specimens, were described by the late Thomas Belt in his admirable "Naturalist in Nicaragua" (2nd ed., London, 1888). In this work he wrote, on pages 381, 382, of the "curious species of Orthoptera that look like green and faded leaves of trees," and especially of some belonging to the genus *Pterochroza*, which "imitate leaves in every stage of decay, some being faded-green, blotched with yellow; others, as in the species figured [p. 381], resemble a brown withered leaf, the resemblance being increased by a transparent hole through both wings that looks like a piece taken out of the leaf." He then went on to refer to butterflies with "similar transparent spots that imitate holes; and others again . . . jagged at the edge, as if pieces had been taken out of them."

The antennae of the species figured by Belt on p. 381 are represented almost exactly as described by Mr. Lankester—held out straight in front of the insect, parallel and close together like a single stalk or slender stem. Both antennae, represented by Belt, would, however, as Mr. Lankester has written (p. lxxxiv), appear as one. The apparent midrib and leaf-veining were very well shown in Belt's figure.

A far less striking leaf-like Tettigoniid—*Plagioptera bicordata* Serv. was represented, on pl. xxxii, figs. 2, 2A, of Trans. Ent. Soc. Lond., 1906, and with it, in figs. 1, 1A, a wonderful Thyridid moth from Trinidad, *Draconia* * *rusina* Druce, the latter resembling in the utmost detail the appearance of a dead, tattered, and skeletonised leaf. Soon after the appearance of this paper a letter was received by Prof. Poulton from Mr. Lechmere Guppy, jun., describing the circumstances

* Also from Guatemala and probably widespread in the South American tropics. The generic name is unfortunately given as *Dracenta* in the plate and throughout the accompanying paper (pp. 533–538).

under which the moth had been captured, and showing that its behaviour in life was such as to promote the dead-leaf-like resemblance. It has therefore been thought well to add to these notes on leaf-like insects extracts from two letters kindly written by Mr. Guppy:—

"*Trinidad,*
"*February*, 23, 1907.

"The moth was taken by me in a cocoa plantation, near a small stream in Tunapuna, at the foot of the northern range of hills. The spot was very shady, cool and damp, and I saw what appeared to be a decayed leaf drifting slowly to the ground from the trees above: *instead, however, of resting on the ground,* it drifted against a small cocoa tree about two feet high, and rested against the stem with wings extended. Had it not been that my eyes are trained by long experience to look out for this kind of thing I might easily have been deceived. It looked like an old battered leaf dislodged from a tree above; and as leaves are often lodged for some time among the Bromelias (locally called 'wild pines'), their condition by the time that a gust of wind might dislodge one of them would be similar to that resembled by this moth."

"*April* 29, 1907.

"The specimen was captured by me as far back as 1902, and though I have often visited the spot since then, I have never seen another; but shortly after 1902 my father sold the cocoa plantation in Tunapuna. The moth was taken near our bathing pool on his property, the elevation being about 200 feet above sea-level, the insect itself was not more than three feet from the ground; the small tree which it 'drifted' against and on which it rested being a 'supply,' *i. e.* a small cocoa tree planted to take the place of an old one, or to fill in a gap between trees rather far apart; the stream ran a few feet away, and although cocoa is planted, there is also an abundance of other vegetation in the vicinity."

Cyrtophora citricola (Epeira opuntiae), a spider from Réunion, etc., spinning egg-cocoons which are white on the flat under surface and green on the convex upper surface, facing the observer.—Prof. Poulton exhibited a

chain of four egg-cocoons kindly sent to him by Mr. G. F. Leigh of Durban, who had explained, in the following passages extracted from his letters, the circumstances in which the specimen was found.

"*November* 21, 1922.

"I am sending you an extraordinary set of four egg-cocoons of a very large spider I found in Réunion, and the resemblance to the lichen on a tree is exact; they were all joined together as sent.

"*January* 15, 1923.

"I am sorry not to be able to send the spider as well. I put it in spirit, but as the cork was not waxed, the liquid evaporated and the specimen was destroyed.

"*April* 10, 1923.

"The cocoons hung down straight from the web, and the spider sat upon the top of the uppermost one (which I conclude was the last constructed), and it so exactly resembled the cocoons that until I disturbed it I did not know it was a spider. Its body was the same size, and the legs were all clustered together underneath it: the colour was grey-green, but when disturbed it showed the underside, which was red-brown and yellow. The legs were grey and black. The males, of which there were two in the web, were very small, with a black body and long, slender, black and grey legs. I found on the ground underneath some wings of moths and also other prey rolled up in silk—evidently the remains of food which had been dropped from the web.

"*May* 1, 1923.

"I found the spider and its cocoons at a place called Hell Bourg, a long distance up the mountain, and surrounded by higher mountains—far and away the most beautiful part of the world I have visited, and that is saying a good deal after having been to the Comoros, Seychelles, Mauritius, and Madagascar, not to speak of South Africa.

"The web was suspended from the underside of the woodwork of a balcony of the hotel. This woodwork projected about six or seven inches beyond the cement wall on which it rested. The cement was covered with a green moss-like growth

encouraged by the moisture; for the mist comes down on most evenings after sunset and makes everything very damp. The web hung in front of this green wall at a distance of about $2\frac{1}{2}$ inches, and the chain of cocoons was suspended vertically in the centre, being kept in position (for the web was very loose) by threads of silk. It was the only example I came across.

"The flat or white side of the cocoons faced the wall, the convex, green side the observer; but I do not think the green colour was adopted because the wall was green, but as a protection to the spider. The whole series did not in any way suggest the presence of a living animal, and I only found out which was the spider when I disturbed it. It then ran away some distance from the cocoons and assumed a terrifying attitude. When I came back with a tube to contain the spider it had returned to its position on the topmost cocoon."

Prof. Poulton consulted Mr. Cecil Warburton on the subject, and he kindly wrote, March 20, 1923, as follows :—

"I thought I remembered something like your cocoons in Vinson's 'Aranéides des Isles de la Réunion, Maurice et Madagascar' (Paris, 1863), and I looked it up to-day. On Pl. IX are drawn three cocoons (green) of *Epeira opuntiae*, and the following account of them is given (quoted from Dumont) on p. 215 :—

"'Elle file une coque en forme de nacelle, qu'elle place au milieu de sa toile dans une position verticale. Cette coque a huit à neuf lignes de long sur six lignes de largeur. Oeufs nombreux. Quelque temps après, elle fixe un autre cocon pareil au premier, ce qu'elle continue de faire jusqu'au nombre de six à neuf. Tous ces cocons sont placés au bout les uns aux autres, comme un chapelet et de manière à ce que leurs extremités se touchant, se croisent, et sont assujetties par un assez grand nombre de fils. Ce qu'il y a de plus remarquable dans ces cocons, c'est la différence de couleur des deux faces : la face convex est verdâtre, et la face plane d'un blanc vif.'"

After receiving this letter it seemed safer to send the cocoons to Mr. Warburton, who replied on March 23 :—

"Many thanks for the cocoons, which I now return. I think

there can be no doubt that they belong to the *Cyrtophora* spider; the description in Vinson is so exact as to size, shape and coloration. The plants it affects are *Opuntia* (a cactus) and *Agave* (aloe), and I should certainly imagine that they lie ordinarily with the flat side against the green stems or leaves of the plants, which the green sides would more or less match. There is, however, a passage in Dumont's description (Vinson, p. 216) which is not very consistent with the idea of camouflage :—

" ' L'on trouve communément de ces toiles dans les habitations abandonnées ou dans les chemins des grands bois qui sont occupés par 12, 15 et même 20 Araignées, et qui ont un nombre plus ou moins grand de cocons rangés en chapelet, posés dans les differentes parties de son étendue, et qui contrastent par leur blancheur avec le fond de la toile qui est gris, ce qui produit un effet assez agréable ' ; but it is not very clear to me whether this refers to the spiders or their cocoons; perhaps the former, which, though mostly dark, have vivid white hairs in part."

When the cocoons were first received and examined with the naked eye, the appearance of the green on the exposed surface, and especially the manner in which it appeared to grow from the margin, suggested that it might be some cryptogamic plant, perhaps encouraged by some special substance in or among the silk threads. With this possibility in mind Miss A. Lorrain Smith was consulted, and she too at first thought that the green colour might be due to some plant-growth; but she soon wrote that, under the microscope, the colour was seen to be caused by green silk spun by the spider. The manner in which the green threads are disposed so as to suggest the above-mentioned interpretation is very remarkable, as also the change in the colour of the silk, from white to green, during the construction of the egg-cocoon.

The attitude of the spider described by Dumont and confirmed by Leigh, was also adopted, with modifications, by other species. Thus in their account of the procryptic colours and attitudes of spiders,* Dr. and Mrs. Peckham describe and

* "Occasional Papers of the Natural History Society of Wisconsin," vol. i, 1889, Milwaukee, pp. 61 *et seqq.*

figure the North American *Uloborus plumipes*, which spins an irregular, untidy-looking web, and in it constructs one or more elongated egg-cocoons, looking like bits of stick or rubbish caught in an old, disused web, and then places itself at one end of a cocoon with its legs stretched out in a bunch in front of it, so that it too looks like another and rather similar bit of rubbish.

Mr. Leigh had suggested (p. lxxxix) that the green colour of the cocoons was a protection to the spider rather than to the cocoons themselves; but these two uses cannot be separated. The spider was well concealed because it resembled cocoons which were well concealed.

An interesting point was raised by the fact that these spiders' webs were so commonly spun on *Opuntia* and *Agave*, both introduced into Réunion and the other islands where this spider was found.* Therefore they could not be the original

* The remarkable nature of the egg-cocoons renders this question of plant distribution an important one. I therefore wrote to my friend Dr. O. Stapf, F.R.S., who has kindly sent the following notes:—

"I am answering your questions about the original countries of Agave and Opuntia and their introduction into Réunion and Mauritius and Madagascar as well as I can. Both genera comprise, as you are no doubt aware, a number of species. There is a great deal of confusion as to the definition and the nomenclature of the species. This is why I said to you yesterday that I may be unable to give a more than general answer.

"*Agave.*—The genus extends from Arizona and Texas through Mexico and Central America to Colombia and possibly to Peru. It has since the sixteenth century become naturalized in most warm parts of the Old World. The common Agave of the Western section of the Mediterranean countries is *A. vera-cruz* whilst *A. americana* is often grown in gardens, both known since the middle of the sixteenth century. *A. vera-cruz* is also the common Agave of India, introduced there probably early in the last century, and it has also become established long ago in Mauritius. In that island *A. americana* has also been known a long time as a garden plant. Another species common in many parts of India is *A. cantala*, introduced into the Dutch Indies in the seventeenth century, whence it spread to India proper. The exact home of neither species is known, although it is very probable that all three came from Mexico. This is practically certain for *A. vera-cruz*.

"*Opuntia.*—This genus too is of American origin, but like Agave it has become naturalized in many parts of the Old World. Opuntia species were introduced into Europe soon after the discovery of America, and *O. decumana*, the *O. ficus-indica* of most authors, and *O. nana* are frequently met with in the Mediterranean countries. Mauritius contains *O. monacantha* and probably *O. decumana*, Madagascar *O. monacantha* and India *O. monacantha*, *O. elatior*, *O. dillenii*, etc. *O. monacantha* and *O. dillenii* were established in Southern India well before the end of the eighteenth century. *O. elatior* can be traced back to the

plants frequented when the cocoon was evolved in its present form. It appeared probable that the original background was provided by the trunks of trees overspread by green cryptogamic growths. In addition to the colour and the way it was distributed on the surface, the boss-like shape of the cocoons also suggested the irregularities of bark, while the flat white under surface appeared to be constructed so as to lie flat on some smooth part of a tree-trunk. The introduced plants, by their abundance and prickly nature, doubtless afforded an advantageous substitute, providing at the same time a green background. It would be of the highest interest to attempt to find out whether, in some remote parts of these islands, the spider still suspended its web to native plants. It should be added that in Madagascar, at any rate, the prevalence of bark-haunting forms with lichen-like colours is especially marked in the moist zone—probably more so than in any other part of the world.

An E. African gregarious spider (Stegodyphus) with its communal nest crowded with remains of a male Pierine butterfly (Mylothris).—Prof. Poulton exhibited the nest referred to in the following extract from a letter received from Capt. W. A. Lamborn :—

"*Fort Johnston,*
"*Nyasaland, September 16th,* 1923.

"I have just despatched a tin box containing a mass of spiders' web on the outside of which are a large number of male *Mylothris* and many other insects. I think that the web must be made gradually by a number of small spiders living communally in it, for several made their escape when I handled it, but I am at a loss to understand what has attracted the insects. The web is certainly sticky, but I have been unable to detect any special odour other than that of the lime leaves on which it has been constructed. There were similar

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end of the eighteenth century when it seems to have been introduced in connection with the attempts to acclimatize the cochenille-insect. According to Burkill the original home of none of those species is *exactly* known. It may, however, be that the American monographers have quite recently been able to locate their native areas more exactly."

webs on other limes, only one other with *Mylothris* in it, and then three only."

Some of the wings of the *Mylothris*, determined by Dr. F. A. Dixey, F.R.S., as *M. rubricosta* Mab., had been removed from the web and were exhibited, together with two Lygaeid Hemiptera, *Graphostethus servus* F. and *Nysius binotatus* Germ.; a Coccinellid beetle, *Ortalia ochracea* Weiss.; a Halticid beetle, *Jamesonia* sp.; an African "green-bottle" fly of the genus *Orthellia* R.D. (= *Cryptolucilia* v. B. and v. B. = *Pseudopyrellia* Girsch.); and three of the spiders,—young examples probably of *S. africanus* Blackw. (Eresidae), the only one of the three S. African species known to occur N. of the Zambesi (R. I. Pocock, F.R.S., in E.M.M., 1903, p. 168).

In the determination of these species, all in an unsatisfactory and some in a fragmentary condition, kind help had been received from Mr. W. E. China, Mr. G. J. Arrow, Mr. G. E. Bryant, Maj. E. E. Austen, and Mr. A. S. Hirst.

The prevalence of specially protected forms in this little assemblage of victims was striking and probably enabled us to make another and an important addition to the list of enemies of distasteful insects.

In an extremely interesting account of these social spiders in Natal and South Africa * Dr. G. A. K. Marshall, F.R.S., helped us to understand the presence of the disproportionate numbers of male *Mylothris* in the nest. From his description it was evident that irregular screens of adhesive silk radiate outwards from the nest, and that when any insect becomes entangled, spiders come out, receiving reinforcements when the prey is large, and drag it into the nest. The larvae of *Mylothris* are gregarious and feed on the parasitic *Loranthus*. It was probable and indeed almost certain that a company had been feeding on *Loranthus* partially enclosed between screens, so that the chances of the emerging butterflies becoming entangled

* "Zoologist, (4), II, p. 417 (1898). Dr. Marshall speaks of the spider as *Stegodyphus gregarius*, O. P. Cambr., but Mr. Pocock, in the paper already quoted (p. 168), thinks it probable that it was *S. dumicola* Poc., the most abundant S. African species. A small nest of *Stegodyphus* was figured of the natural size by the late Mr. W. L. Distant (*ibid.*, p. 253).

on their first flight were extremely high. The uniform sex was probably to be accounted for by the capture of the earliest emergences, which are usually males; or it may be that *Mylothris rubricosta* produces companies of one sex, and that this happened to be an all-male family.

Among other interesting facts described by Dr. Marshall was the mimetic resemblance borne by the nests of certain Sunbirds to those of *Stegodyphus*. The position chosen was similar to that of the spiders and the birds' nests were bound with spiders' web collected for the purpose.

Dr. Marshall also found several deserted spiders' nests enclosing in the centre a ball of grass, wild cotton, or feathers. The explanation became clear when he encountered, near Salisbury, Mashonaland, a number of spiders constructing a new nest and evidently in a state of great perturbation. Opening the old nest Dr. Marshall found four little Dormice, whose mother had evidently turned the spiders out of their home and taken possession. The spiders were endeavouring to put as great a distance as possible between them and their enemy. They had passed, by strands of web about four feet long, from the original bush to another, and on again by strands to a third about six feet distant, and on the side of a termite heap opposite to that of the original bush. But some at least were still unsatisfied, for about "fifty of them were standing together with abdomen in air pouring forth a regular stream of silk in hopes of connecting with another tree. In one case a few threads caught on to a tree fully twelve feet away; the near ends were then promptly fastened down, and a spider would advance cautiously along, strengthening the thread and hauling in the slack as she went, but in every case the thread broke. After many attempts to thus retreat further they gave it up, and went on with the work of making a new nest" (*ibid.*, p. 422).

Dr. Marshall also discovered the larvae and pupa-cases of a Tineid moth living in the nests of *Stegodyphus* and presumably feeding on the débris. The moths were subsequently reared by Mr. Pocock and Lord Walsingham, who described the species as *Batrachedra stegodyphobius* (E.M.M., vol. 39, p. 166, 1903). Mr. Pocock had given an interesting account

of the habits of the larvae and moths, and described the manner in which the latter evade the spiders, although he considered that both were probably protected in some way against their attacks. There could be no doubt that the spiders were able to capture the larvae and freshly emerged moths, but in the few examples in which the former were seen to be eaten the spiders displayed no avidity. The advantage to the Tineid was obvious, for it gained both security and food: the only advantage to the spider that had been suggested was that of having scavengers in the nest (*ibid.*, pp. 168–70).

VARIETIES OF EUROPEAN BUTTERFLIES.—Mr. J. J. LISTER exhibited (1) a short series of Lycaenids (*Polyommatus* (*Agriades*) *coridon*, *P.* (*A.*) *thetis* (*bellargus*), *Plebeius* (*Aricia*) *medon*, *P.* (*A.*) *pheretes*, *P. aegon* (*argus*), and the Hesperid, *Urbicola* (*Augiades*) *comma*, showing the radiate type of aberration; (2) three specimens of *Zerynthia* (*Thais*) *polyxena*, race *cassandra*, taken at Costabelle, Hyéres, in which the crimson of the spots on the upperside of the hind-wing is replaced (except in the most anterior spot) by buff; (3) two varieties of *Tomares* (*Thestor*) *ballus*, taken at Costabelle and (4) a specimen of *Melitaea dictynna*, from Gavarnie with melanic variation of the fore-wing.

Papers.

The following papers were read :—

1. "On *Pseudacraea eurytus* and its models in Eastern Uganda," by Dr. G. D. H. CARPENTER.

2. "On the Oriental Carabidae of the Reise Novara," by Mr. H. E. ANDREWES.

Wednesday, December 5th, 1923.

Mr. J. E. Collin, F.Z.S., Vice-President, in the Chair.

Obituary.

The Chairman announced the death of Colonel Charles Swinhoe, a Fellow of the Society.

Nominations for 1924.

The Secretary again read the list of nominations of Officers and Council for the ensuing year.

Election of Fellows.

The following were elected Fellows of the Society:—Mr. R. Cottam, Entomological Dept., Wellcome Tropical Research Laby., Khartoum, Sudan; Mr. G. D. Morison, B.Sc., Research Entomologist, North of Scotland Agric. College, Aberdeen; Capt. T. N. C. Nevill, 48, Sloane Square, S.W.

Exhibitions.

Butterflies from Kamerun.—Mr. G. T. Bethune-Baker exhibited an interesting assemblage of synaposematic butterflies from Kamerun which included as models *Deïlemera acraeina* Druce, and *Planema macaria macarioides* Auriv., *P. macarista* Sharpe, *P. epaea* Cr., and *P. elongata* Butler, with them being associated the Satyrids *Elymniopsis bammakoo* Westw., and *E. phegea* Fab., and the Nymphalids *Pseudacraea theorina* Auriv., and *P. ruhama* Hew.

A Method of Mounting Coleoptera.—Mr. J. E. Campbell-Taylor exhibited a number of beetles mounted on celluloid.

Rare British Microlepidoptera.—Mr. W. G. Sheldon exhibited *Ancylis tineana* Hb., the second British specimen, taken at Rannock in June 1923, and *Hedya simplana* F. von R., a specimen from south-east Kent bred in June 1923, the larva feeding upon aspen.

Melanargia galatea and its varieties.—Mr. E. B. Ashby exhibited the following varieties of *Melanargia galatea* L.: the typical form from Fontainebleau; var. *procida* Hbst., from Digne, Turin, and Arquata, Piedmont; ab. ♀ *leucomelas*

Esp., from Digne; ab. *turcica* Boisd., an extreme form of the melanic type from Rosans and Digne; and var. *latelians* Oberth., from Montmien, near Nemours station.

A Brazilian Erycinid and its remarkable pupa.—Dr. Karl Jordan exhibited a cluster of pupae of the Erycinid *Mesosemia sylvina* Bates, found at Pará by the Rev. A. Miles Moss, F.E.S. The pupae are fastened in an upright position by the tail-end to the stem or twig of a plant (evidently herbaceous), and are so arranged in clusters of three along the stalk that the whole resembles a verticillate inflorescence with seed-pods or dried-up buds. The stalk of the plant is covered with silk, and threads of silk run from the stalk on to the posterior segments of the pupa, which are flattened beneath and closely appressed to the stalk. There is no girdle. The chrysalis is of a dirty brown colour, slightly striped longitudinally, and covered with very small bristles. The second abdominal segment is dorsally slightly humped transversely, and the head bears on each side a small black tubercle. The larva and food-plant are not known.

Dimorphism in Male Dynastid beetles.—Mr. Gilbert J. Arrow, who illustrated his remarks with lantern slides, said :—

" A few years ago I described at a meeting of this Society a peculiar case of dimorphism in the males of a Dynastid beetle (*Enema pan* F.) inhabiting Tropical America. Until recently I have never met with a similar case, but to-night I wish to call attention to an interesting parallel in a related species (*Trichogomphus lunicollis* Burm.) ranging from Siam to Borneo and Sumatra.

" In horned beetles generally the horns are subject to great variability in the degree of development. In small individuals they may be reduced almost to vanishing point, and the largest specimens invariably show them at their maximum. Between the extremes every transition occurs, and all specimens can be ranged in a single uniform series. In *Enema pan* the female, as well as the males, is horned, the head bearing a rather long-pointed horn and the prothorax a very short doubly-pointed one. Small males resemble the female, and large specimens have a very long but simple horn on the head

and a long forked one on the thorax. But large examples also occur (known as *Enema infundibulum* Kirby) in which the horns appear as though reversed—the one upon the head is double and that on the thorax single. No intermediates are found, no minor developments and no distinct female form. I therefore regard it, not as a distinct species, but as an isolated variety or mutation.

" The second case has also been considered hitherto as consisting of two different species, *Trichogomphus lunicollis* Burm., and *T. alcides* Voll. It is closely related to *Enema pan* F. The female, again, has a long horn upon the head and a short doubly-pointed one upon the thorax, and small males resemble the females. In larger males the head-horn is longer and the thoracic horn broader, the two points of the latter diverging more and more according to the degree of development until at the maximum they are separated by almost the width of the body. But another maximum form occurs (*T. alcides* Voll.) in which, instead of spreading out, the thoracic horn is contracted and produced, and the cephalic horn also assumes a different shape. It has a much stronger curvature, a very large tooth near the base (instead of a small one near the middle) and a dilated tip. Here, again, no transitional phase is known, only the largest individuals appear to assume the *alcides*-form, and no separate female form can be distinguished. The two cases are closely parallel, but whereas the *infundibulum* form of *Enema pan* occurs throughout the range of the species, from Mexico to S. Brazil, the *alcides* form of *Trichogomphus lunicollis* seems to be confined to Borneo.

" These two insects are rather exceptional in the possession of well-developed horns in the females, and the female armature forms the minimum standard for the male, even the smallest examples of which do not fall below that level.

" I am also showing a few slides which may throw some light upon the evolution of the thoracic horn in this group of beetles. As shown by the two cases just discussed, this horn appears to arise as a prolongation of the middle of the hinder margin of a pre-existing cavity in the pronotum. Two little anterior points in the side walls of the cavity very commonly project also. The cavity frequently contains hair, which is

also present upon the head, the extremity of the body and the lower surface. In my opinion the prototype of all these beetles was entirely clothed with hair, and this has tended to disappear first from the most exposed portions of the body. In *Heterogomphus hirtus* the hair is retained upon the whole body except the cephalic horn and the upper surface of the thoracic one. In *H. ulysses*, as in most males, it has disappeared also from the elytra, although in many females it is more or less retained, as in the genus *Dynastes*. In *Dynastes neptunus* the lateral horns are very conspicuous; in *D. hercules* they appear halfway along the dorsal horn, and in *Golofa claviger* towards its end; but in each case the hollowed lower surface of the horn between these lateral points and the apex is filled with hair, indicating, in my opinion, that this represents the primitive hairy dorsal cavity, which has become greatly attenuated and inverted in position."

Dr. K. Jordan said that a similar polymorphism correlated with exceptionally large individuals occurred in the males of other families of Coleoptera; but that dimorphism in male Lepidoptera was very rare and not connected with secondary sexual characters. Such dimorphism is difficult to explain on genetic grounds.

Mr. J. E. Collin initiated a discussion on methods of collecting in which Mr. Sheldon, Commander Walker, Mr. Willoughby Ellis, Mr. Balfour-Browne and others took part.

Papers.

The following papers were read :—

1. " Notes on the Orthoptera in the British Museum, No. 3," by Mr. B. P. Uvarov.

2. " Physical Factors controlling Harvesting in an Ant," by Dr. P. Buxton.

3. " On Microlepidoptera of Rodriguez," by E. Meyrick, B.A., F.R.S.,

4. " On the Geographical Races of *Heodes phlaeas*," by Mr. E. B. Ford. (Communicated by Commr. J. J. Walker R.N., M.A.)

5. " Some Coleopterous remains from the Peat Bed at Wolvercote, Oxford," by Mr. K. G. Blair.

ANNUAL MEETING.

Wednesday, January 16th, 1924.

Mr. E. E. GREEN, F.Z.S., President, in the Chair.

Dr. H. ELTRINGHAM, one of the Secretaries, read the following

Report of the Council.

The Council is again able to report satisfactory progress in the various activities of the Society during the year.

The steadily improving financial position will be dealt with in the Report of the Treasurer.

The losses amongst Fellows through death have been unusually small, only 6 having died during this year, but 15 have resigned, and 10 have been removed for non-payment of subscription. The number of new Fellows elected is 41, and this number, though somewhat less than last year, when 54 joined the Society, is nevertheless a high one. The Society now consists of 12 honorary, 2 Special Life, and 697 Ordinary Fellows, making a total of 711, this being for the fourth year in succession the largest in its history. The Society has in fact increased by 83 in the last four years, and the Council is of opinion that the time may not be far distant when some limitation of the Fellowship may become advisable.

The volume of Transactions and Proceedings will this year have quite regained the pre-war standard, both as regards text and illustrations, indeed Parts III and IV are probably amongst the finest the Society has ever produced.

The Transactions will consist of some 680 pages comprising papers by the following authors :—

H. E. ANDREWES, 2; H. J. CARTER, 1; G. T. BETHUNE-BAKER, 1; Dr. M. BURR, 1; Dr. JEFFERIS TURNER, 1; F. MUIR, 1; Dr. R. J. TILLYARD, 2; C. B. WILLIAMS, 1; T. G. SLOANE, 1; G. B. WALSH, 1; Professor SILVESTRI, 1;

Dr. H. Eltringham, 3; C. L. Withycombe, 1; Dr. J. Waterston, 1; M. E. Mosely, 1; G. C. Champion, 1; A. Philpott, 1; R. W. Jack, 1; Dr. G. D. H. Carpenter, 1; B. P. Uvarov, 1; Dr. P. A. Buxton, 1; Edward Meyrick, 1; K. G. Blair, 1; Professor E. B. Poulton, 1; and E. B. Ford, 1.

Of these, 12 deal with the Lepidoptera, 7 with Coleoptera, 4 with Neuroptera, 2 with Orthoptera, and one each with Thysanura, Diptera, Mallophaga, and Hymenoptera.

The volume is illustrated by 54 plates, of which 19 are line block, 21 half-tone, 3 lithograph and 11 colour.

The Proceedings will consist of about the usual number of pages with some text illustrations.

The originals of all the illustrations have been provided by the authors; blocks for those of Professor Silvestri's paper were presented by Mr. K. J. Morton; a contribution was received towards the cost of one of the coloured plates from Dr. H. Eltringham, who also provided the original for the plate illustrating Mr. Ford's paper. The Society is indebted to Professor Poulton for the very handsome gift of the whole of the 25 plates for his paper, the cost of which he has authorised to be paid from the Fund for the promotion of the Study of Organic and Social Evolution, presented in his name to the University of Oxford by the distinguished Psychologist, Professor James Mark Baldwin.

The detailed work of the Society's business has been carried on by a Finance and Housing Committee under the Chairmanship of Mr. R. Adkin, a Publications Committee under that of Professor E. B. Poulton, F.R.S., and a Library Committee under that of Mr. J. E. Collin. The thanks of the Council are again due to the Fellows serving on these Committees for their valuable assistance.

In view of the serious financial situation of the Zoological Record, and in response to an appeal for funds, the Council has voted the sum of £50 towards the cost of the 1922 volume of that Publication. In this connection Dr. S. A. Neave has been nominated to serve on a Committee that will watch the interests of the Societies contributing to the cost of the Record.

The Librarian reports that the sum allotted by the Council during the year for the card index has been or will be expended

early in 1924 in purchasing the necessary cabinets, cards and other equipment, and in obtaining extra assistance in the making up of the cards. So much progress has been made that cards have now been compiled for the whole of the books and separata in the Society's possession, and these cards are in their places in the cabinets. It now remains to identify each item with its card, a work which will take much time. Opportunity will be taken to classify the works according to the main orders of insects, so far as can usefully be done.

The funds available have been spent on new books, magazine subscriptions and binding, and a large amount of rebinding is in hand.

The result of sales of the Society's Publications, particulars of which will be given in the Treasurer's Report, is again most satisfactory.

It is hoped that in 1924 the income from the investment of the Druce Bequest will be available for the acquirement of new books.

The Report was adopted on the motion of Commander J. J. WALKER, seconded by Mr. STANLEY EDWARDS.

The Treasurer's Report.

Mr. W. G. SHELDON, the Treasurer, read the following Report:—

I am so fortunate as to be able to report to the Society that the past year has been at least as successful as any of its predecessors from a financial point of view.

The Housing Fund has increased during the year by £859 3*s.* 4*d.*, made up of £285 13*s.* 8*d.* donations, and the large amount of £573 9*s.* 8*d.* saved by the Society out of its income, and devoted to this Fund. Amongst the donations we have again to thank Mr. ROBERT ADKIN for cancelling Debentures drawn to the extent of £90. The sum saved from the Society's income consists of: (1) £200 allotted annually by resolution of the Council. (2) The surplus of the amount received for rents in 1922, over the interest paid on Debentures, and after allowing an adequate amount to provide for the cost of repairs to the premises. The amount of this surplus was £152 14*s.* 7*d.*

(3) After all the liabilities incurred in 1922, but that were unpaid at the end of that year, had been liquidated, it was found there was a surplus of £220 15*s*. 1*d*. It is a very usual and proper course to adopt, that any surplus apparent at the end of a year shall go towards the redemption of debt, and this surplus for this reason has been added to the Housing Fund. These amounts, with the balance in favour of the Fund carried forward from 1922 of £695 18*s*. 8*d*., have allowed for the redemption of Debentures during the year to the amount of £1500, leaving an amount of £48 18*s*. 6*d*. in hand.

The rate at which the Debentures are being redeemed is really remarkable. A year ago I ventured to forecast that I expected Debentures would be redeemed during 1923 to the extent of £1000. It will be seen that this forecast has been exceeded by no less than 50 per cent. The occupation of a prophet is proverbially difficult, and I have found it so in endeavouring to estimate the probable amount of assistance rendered by the Fellows to the Society during the last few years. My most sanguine anticipations have not only been invariably realised, but exceeded, and I feel sure the assistance rendered in the past will be continued to an equal extent in the future. The amount of Debentures outstanding at present is £2225 as compared with £3725 a year ago. At the date of our entering upon the enjoyment of our new home at 41 Queen's Gate early in 1921, the amount of Debentures created was £5290. It will be seen that in the three years that have elapsed since then, Debentures to the extent of £3065 have been redeemed, or almost three-fifths of their original amount. I cannot anticipate the action of the Council during the coming year, but I trust that there will be a further heavy liquidation of debt during its currency.

There has been some delay in receiving the legacy of £1000 from the late HAMILTON H. C. DRUCE, but I have recently received £250 of it, and I learn from the solicitor that the balance is likely to be forthcoming shortly.

As already announced, another splendid legacy of £1000 arising out of the will of the late Hon. N. C. ROTHSCHILD has during the past year been received by the Society. This legacy is left quite unconditionally.

The amount received from the sale of Publications has been slightly less in 1923 than in 1922, amounting to £317 2*s.* 2*d.* as against £337 14*s.* 1*d.* Still it represents more than double the average amount received from this source under the old conditions. I look upon this result as one of the most eloquent testimonials of the Society's status. The world buys our Publications now in larger quantities simply because it recognises our increased prestige and position.

The amount from the current year's subscriptions received in 1923 increased by £41 7*s.* 6*d.*, the total of these being £1210 16*s.* 0*d.* Arrears of subscriptions received also increased by £27 13*s.* 0*d.* The amount of arrears of subscriptions owing at the end of the year was £37 less than was the case a year previous. The amount received from Admission Fees, owing to fewer Fellows being elected, was £25 4*s.* 0*d.* less. The income arising from property after paying Debenture interest and making provision for cost of repairs to premises has been £166 5*s.* 0*d.*

Turning to our payments, the amount spent on the Publications is £72 2*s.* 7*d.* less than in 1922. The reason for this is, that Parts I and II, 1923—the only portion of the 1923 Publications issued during the current year—is rather an inexpensive one. Parts III and IV, to be issued shortly, having much more matter and many more plates, will more than make up for this.

The amount spent on the Library has been £122 15*s.* 9*d.*, including £59 4*s.* 11*d.* for new books and £37 2*s.* 2*d.* in the preparation of a much-wanted card index of the books and pamphlets. The other items of expenditure are about the same as last year and do not call for special notice.

The balance of income over expenditure in 1923, after providing for outstanding liabilities, amounts to the substantial sum of £103 2*s.* 1*d.*

The Council has been advised that the electric lighting installation at 41 Queen's Gate requires renewing so far as the wiring is concerned. Mr. Willoughby Ellis has most generously offered to do this work by his firm at cost price, and further to contribute the sum of £50 towards the expense. The balance of the necessary expenditure can be financed out

of the Society's current funds. It is intended to install the new wiring at once, and in doing so arrangements will be made to carry it out without interfering with the Society's convenience and activities. Our warm thanks are due to Mr. Willoughby Ellis for his generous assistance.

Portraits of the following distinguished Fellows have been procured and hung in the Meeting Room during the past year: Charles Darwin, Robert McLachlan, Raphael Meldola, Edward Newman, Francis P. Pascoe, Henry Rowland-Brown, Edward Saunders, Sir Sidney Smith Saunders, William Wilson Saunders and David Sharp. Others will be added during the coming year.

There are large numbers of men who in their day were well known in entomology, and whose portraits the Society ought to possess, not necessarily for hanging on the walls—there is not space enough for all—but so that their lineaments may be handed down to posterity. Albums of portraits—other than those that have been hung—are being prepared, and I should be extremely grateful if any Fellow possessing portraits of well-known entomologists that they would be willing to present to the Society would communicate with me.

The above facts will, I trust, be held to justify the opinions I hold as to the Society's satisfactory financial position, but there is one more point I should like to mention. At the end of 1919, the last year under the old conditions at Chandos Street and previous to its new financial programme having an effect, in the eighty-six years of its existence the Society had accumulated invested funds amounting to £870 17*s*. 10*d*., as valued in the statement of assets for that year.

Four years afterwards our invested funds amounted to £5448 9*s*. 4*d*. That is to say, they have increased by £4577 11*s*. 6*d*. or more than five times their value in 1919, and then we have, or should have early in the coming year, over £2000 to invest.

Some fifty years ago a famous Chancellor of the Exchequer, making his Budget speech, spoke of the prosperity of the country as "increasing by leaps and bounds." May we not too say that the substantiality of the Society's financial position is "increasing by leaps and bounds"?

The Treasurer also read a few extracts from the Financial Statement, and the Report and Accounts were adopted unanimously on the motion of Mr. G. T. Bethune-Baker, seconded by Mr. W. J. Kaye.

The President announced that the Fellows nominated as Officers and Council for the ensuing year had been duly elected in accordance with the Bye-Laws.

The President then read his Address, and at its conclusion a vote of thanks to him, coupled with a request that it might be printed in the Proceedings, was moved by Professor E. B. Poulton, F.R.S., seconded by Mr. K. G. Blair, and carried unanimously.

A vote of thanks to the Officers for their services was then passed on the motion of Mr. H. Willoughby Ellis, seconded by Mr. W. Rait-Smith, and Mr. W. G. Sheldon, Dr. H. Eltringham, and Mr. H. J. Turner briefly replied.

TREASURER'S ACCOUNTS for the Year ended December 31, 1923.
(Presented at the Annual Meeting, January 16, 1924.)

RECEIPTS AND PAYMENTS ACCOUNT.

RECEIPTS.	£	s.	d.	£	s.	d.
To Cash at Bank and in hand as per last Account—						
General Account	682	18	4			
Compounding Fund	82	7	10			
Library Fund	5	3	3			
Repairs to Premises Fund	90	11	11			
				861	1	4
„ Interest on Investments—						
Birmingham 3% Stock (Westwood Bequest)	7	3	8			
Consols	33	17	0			
National War Bonds	22	12	1			
„ Interest on Deposit—						
General Account	12	18	7			
„ Rents from Sub-tenants	390	0	0			
				466	11	4
„ Contribution by Tenants towards House Expenses				137	13	2
„ Admission Fees				138	12	0
„ Annual Subscriptions—						
Arrears	92	13	0			
1923	1,190	19	0			
Advance	35	14	0			
				1,319	6	0
(Subscriptions for 1923 received in 1922, £17 17*s.*)						
„ Sales of Publications				317	2	2
„ Miscellaneous Receipts				2	19	4
„ Bequests—						
The late Hon. N. C. Rothschild	1,000	0	0			
The late H. H. C. Druce (£1,000) on account	250	0	0			
				1,250	0	0
				£4,493	5	4

PAYMENTS.	£	s.	d.	£	s.	d.
By Salaries				318	10	0
„ Library—						
New Books	59	4	11			
Binding, Repairs and Insurance... ...	26	8	8			
Preparation of New Catalogue	37	2	2			
				122	15	9
„ Cost of Publications—						
Printing and Distribution	577	11	10			
Illustrations	91	7	5			
				668	19	3
„ Sundry Printing and Stationery				45	16	4
„ Postage				20	5	4
„ Audit Fee				10	10	0
„ Miscellaneous Expenses				57	9	1
„ House Expenses—						
Fuel, Gas, and Electric Light	61	7	10			
Insurance...	12	15	3			
Water	18	15	0			
Repairs to Premises	7	3	0			
Additions to Furniture...	67	6	5			
Sundry Expenses	5	15	6			
				173	3	0
„ Interest on Debentures (less tax)... ...	132	14	7			
„ Income Tax thereon	36	17	1			
				169	11	8
„ Purchase of £76 9*s.* 8*d.* National War Bonds, 1928				81	18	0
„ Transfer to Housing Fund				573	9	8
„ Cash at Bank and in Hand (including £1,917 on Deposit)—						
General Account	1,755	4	6			
Westwood Bequest Fund	7	3	8			
Hamilton Druce Fund	250	0	0			
Compounding Fund	69	15	10			
Library Fund	15	4	4			
Repairs to Premises Fund	153	8	11			
				2,250	17	3
				£4,493	5	4

STATEMENT OF ASSETS AND LIABILITIES—DECEMBER 31, 1923.

Assets.

		£ s. d.	£ s. d.
To Freehold Premises, 41 Queen's Gate, Cost of Purchase			6,250 0 0
„ Library, Furniture and Fittings ...		Not valued *	
„ Present value of—			
£1,354 2*s.* 2*d.* 2½% Consols, Compounding Fund (Cost £1,233 3*s.*)		751 10 7	
£490 7*s.* 9*d.*, 5% National War Bonds 1928 (3rd Series), Compounding Fund (Cost £487 15*s.* 8*d.*)		518 11 8	
£239 12*s.* 4*d.* Birmingham Corporation 3% Stock (Westwood Bequest—Cost £250)		153 7 1	
			1,423 9 4
„ Amounts due to the Society—			
Subscriptions		130 6 0	
Admission Fees		15 15 0	
Publications		39 0 6	
Rents and Contributions to House Expenses		132 10 0	
Sundries		1 6 3	
		318 17 9	
Less not considered good		25 0 0	
			293 17 9
„ Cash at Bank and in Hand—			
General Account:			
On Deposit	1,917 0 0		
In hands of Secretary ...	3 0		
In hands of Treasurer ...	2 2 0		
	1,919 5 0		
Less Current Account Overdrawn	164 0 6		
		1,755 4 6	
Housing Fund—Current Account ...		48 18 6	
Compounding Fund—Current Account		69 15 10	
Library Fund—Current Account ...		15 4 4	
Repairs to Premises Fund—Current Account		153 8 11	
Westwood Bequest Fund—Current Account		7 3 8	
Hamilton Druce Fund—Current Account		250 0 0	
			2,299 15 9
			£10,267 2 10

Liabilities.

	£ s. d.	£ s. d.
By Amounts Due from the Society—		
Printing Transactions, Parts III, IV, and V	535 0 0	
Sundry Accounts	117 2 5	
		652 2 5
„ Subscriptions received in Advance ...		35 14 0
„ 5 % Debentures—		
Issued to provide for Purchase of 41, Queen's Gate, S.W.:		
As at 1st January, 1923	3,725 0 0	
Less Repaid during year ...	1,500 0 0	
	2,225 0 0	
Add Interest Accrued	27 16 3	
		2,252 16 3
„ Excess of Assets over Liabilities—		
General Account	1,333 9 7	
Housing Fund	4,073 18 6	
Compounding Fund	1,339 18 1	
Library Fund	15 4 4	
Westwood Bequest Fund	160 10 9	
Hamilton Druce Fund	250 0 0	
Repairs to Premises Fund	153 8 11	
		7,326 10 2
		£10,267 2 10

WESTWOOD BEQUEST FUND.

Receipts.	£	s.	d.	Payments.	£	s.	d.
To Interest on £239 12*s.* 4*d.* Birmingham 3% Stock ...	7	3	8	By Balance at Bank at date	7	3	8

HAMILTON DRUCE FUND.

	£	s.	d.		£	s.	d.
To Received on Account of Legacy (£1,000) in 1923 ...	250	0	0	By Balance at Bank at date	250	0	0

LIBRARY FUND (NEW BOOKS).

	£	s.	d.		£	s.	d.
To Balance at Bank, January 1, 1923	5	3	3	By Expenditure on New Books	59	4	11
,, One-half of Admission Fees received in 1923 ...	69	6	0	,, Balance at Bank at date	15	4	4
	£74	9	3		£74	9	3

COMPOUNDING FUND.

	£	s.	d.		£	s.	d.
To Balance at Bank, January 1, 1923	82	7	10	By Investment in £76 9*s.* 8*d.* 5% National War Bonds, 1928 (3rd Series)	81	18	0
,, One-half of Admission Fees received in 1923	69	6	0	,, Balance at Bank at date	69	15	10
	£151	13	10		£151	13	10

HOUSING FUND (TOTAL RECEIPTS AND PAYMENTS TO DECEMBER 31, 1923).

Receipts.	£	s.	d.	Payments.	£	s.	d.
To Receipts to December 31, 1922	10,723	16	4	By Payments to December 31, 1922	10,027	17	8
„ „ in 1923	859	3	4	„ „ in 1923	1,506	3	6
				„ Cash at Bank at date	48	18	6
	£11,582	19	8		£11,582	19	8

HOUSING FUND (AMOUNTS RECEIVED IN 1923).

	£	s.	d.		£	s.	d.
To Balance at Bank as per Last Account	695	18	8	By Repayment of Debentures	1,500	0	0
„ Transfer from General Account	573	9	8	„ Stationery and Printing	6	3	6
„ Donations	285	13	8	„ Cash at Bank at date	48	18	6
	£1,555	2	0		£1,555	2	0

REPAIRS TO PREMISES FUND.

	£	s.	d.		£	s.	d.
To Balance at Bank, January 1, 1923...	90	11	11	By Payments	7	3	0
From General Account for 1923	70	0	0	„ Cash at Bank at date	153	8	11
	£160	11	11		£160	11	11

W. G. Sheldon, *Treasurer*.

We have audited the Treasurer's Accounts of Receipts and Payments and the Statement of Assets and Liabilities with the Books and Vouchers of the Society, and certify them to be correct. Messrs. Burch & Co., Solicitors, of 6 Bolton Street, W., have certified to us that they hold the deeds of the property on behalf of the Trustees for the Debenture Holders. We have verified the other Investments and Bank Balances.

(Signed) W. B. Keen & Co., *Chartered Accountants*.

23, Queen Victoria Street, London, E.C. 4.
January 15, 1924.

THE PRESIDENT'S ADDRESS

Ladies and Gentlemen,

It is customary for the President to commence his Address with a few comments upon the Reports of the Council to which you have just been listening. From the Secretaries' Report you will have gathered that the Society is still making good progress, and that, on balance, there has been an accession of fourteen Fellows during the year, making a total increase of eighty-three within the last four years. I think you will agree that this is a satisfactory position of affairs and that it indicates a growing interest in our Science and our Society. The Treasurer's Report is equally satisfactory, showing, as it does, that the Society's financial affairs are in a thoroughly sound state, as is evidenced by the large amount of Debentures repaid, or relinquished by the generosity of the holders, as also by the increased receipts from subscriptions and other sources. I feel sure that you will agree with me that our sincere thanks are due to our Honorary Secretaries, Treasurer and Librarian, to whose untiring energy and devotion to our interests the present satisfactory status of our Society is largely due.

I am glad to be able to report that the losses to our Society by deaths have been relatively few, though they include the names of two of our most distinguished Fellows.

The Rev. Canon Fowler, who died on the 3rd of June last, was President of our Society during the years 1901 and 1902. A devoted study of the Coleoptera, prosecuted for many years, culminated in the publication of his monumental work upon the Coleoptera of the British Islands—a work that is indispensable to all students of this Order in these islands.

Nathaniel Charles Rothschild, whose untimely death at the age of forty-six we have had so recently to deplore, presided

over our Society in 1915–16, and his deep interest in our concerns was evidenced by a generous provision in his will by which the Society has benefited to the extent of £1000. His researches upon the sub-order Siphonaptera, of which he was the recognised authority, by their bearing upon the causation of bubonic plague provide a notable example of the close interconnection of the Pure and Applied Sciences. His very extensive and valuable collection of these insects now enriches the National Museum of Natural History. A very happy and charming disposition endeared him to all who were personally acquainted with him.

Colonel Charles Swinhoe was known to us chiefly through his work upon Indian Lepidoptera and, more particularly, by his successful completion of the "Lepidoptera indica," after the death of Dr. F. Moore.

Robert Etheridge was for many years Curator of the Australian Museum at Sydney, N.S.W. Though a Fellow of our Society, his special interest was Geology, and he is said to have been one of the chief authorities on the Geology of Australia.

Of Albert E. Hall I have been unable to obtain any particulars, except that he was a well-known Yorkshire entomologist.

I used to hold the view that the ideal Presidential Address should be in the form of a comprehensive review of all notable work and new discoveries that have enriched our knowledge of Entomology during the preceding year. I now realise that this is a "counsel of perfection." The present is an age of specialism. There are few men now living with a sufficiently wide knowledge to cover the vast field that embraces all the branches of our science throughout the world. I, most assuredly, recognise my incompetence to attempt such a review.

Two other alternatives are open to me. The first is, to give a dissertation on the one subject upon which I am supposed to have some special knowledge. I hasten to reassure you by saying that I do not propose to weary you with a thesis upon the Coccidae. The second alternative is to select a subject of wider interest—a procedure that was adopted by my immediate predecessor, from whose admirable and interesting

address on " Algeria and its Fauna " we all derived so much pleasure. I feel that I cannot do better than attempt to follow his lead, and have accordingly chosen, as the title of my Address,

"Some Episodes and Aspects of Insect Life in Ceylon."

It was my original intention to survey the whole class of Insecta; but, during the preparation of the following Address, I found it impossible to condense my remarks into a sufficiently small compass, and that the time at my disposal to-night would be exhausted by merely a brief study of the Order Lepidoptera. I may, perhaps, be allowed an opportunity of completing the survey on some future occasion.

During a residence (with brief intervals) of thirty-two years in Ceylon I had ample opportunities of indulging an inborn love of Natural History, and I fear that, during my earlier years as a Planting apprentice, I sometimes paid undue attention to the fauna and flora of the country to the neglect of the more monotonous duties of coolie-driving. It was gratifying, in after years, upon my appointment to an official post as Government Entomologist, to be able to combine business with pleasure and to devote myself entirely to entomological pursuits.

At first, everything was so new to me that I did not know what was worthy of record and what was ancient history. I had not, then, the advantage of the acquaintance of our distinguished Fellow, Professor Poulton, who has been, with such happy results, the inspiration of more recent workers in tropical countries. But I proceeded, to the best of my ability and in the limited time at my disposal, to make notes and drawings of everything that interested me. Of course many of my observations were scientifically valueless and my deductions erroneous; but they were all of educational value to myself, and, amongst the accumulation of material, there has been found some good grain that has since borne fruit. My advice to any young entomologist who may find himself in a similar situation is to start on the assumption that everything is new and worthy of record, until he can get into touch with some such guiding spirit as I have described.

You can, no doubt, picture to yourselves the excitement of a young entomologist—fresh from England—upon finding himself, for the first time, in a tropical island, with its teeming insect life. My first day in Colombo introduced me to more species of butterflies than one usually sees in England during a year. Gorgeous "Swallow-tails" such as *hector*, *aristolochiae*, *demoleus*, *parinda* and *polytes* (with its remarkable polymorphic females), together with the strikingly beautiful Nymphaline, *Hypolimnas bolina*, were common objects in every garden and even in the public streets of the town.

As compared with the sixty-eight butterflies figuring on the British lists, approximately two hundred and thirty species have been recognised in Ceylon. It is difficult to fix the exact number, as authorities differ in their conception of varieties and species. The several families are represented in the following proportions:—Nymphalidae 70 species; Lemoniidae 4; Lycaenidae 70; Papilionidae 43 (comprising 15 Papilios and 28 Pierines); Hesperiidae 42.

It is the relative number of Papilios—both in number of species and individuals—that strikes the new-comer more particularly; principally, no doubt, on account of their large size and brilliant colouring. The more common species—such as *parinda*, *demoleus* and *polytes*—are to be seen everywhere, from sea-level upwards, in highways and byways, in town gardens and in the open country. Their larvae feed upon various species of *Citrus* and occur commonly on the orange trees that are cultivated in every garden. The larva of *parinda* is a particularly striking object, somewhat of the form and pattern that has been adopted by our British "Elephant Hawk" caterpillars, the third and fourth body segments being swollen and adorned with a large eye-like spot on each side. This pattern, doubtless, serves the same purpose in both cases. *Papilio polytes* provides an interesting puzzle to the novice. He collects a dozen similar larvae from the same bush and raises therefrom what appear to be three or more completely distinct butterflies. It is not till later that he learns that they are all forms of the female of one and the same species, and that two of these forms are excellent mimics of two other species belonging to another and distasteful group.

A traveller in the drier areas of Ceylon will sometimes find himself suddenly involved in a whirling cloud of butterflies, disturbed from some roadside puddle at which they had been refreshing themselves. I have seen the radiator of a motor-car plastered with many-hued wings, after its passage through such a cloud. These congregations are principally composed of Pierine and Papilionine species, such as *nomius*, *jason*, *agamemnon* and *teredon*, with *Hebomoia australis* and various kinds of *Appias* and *Catopsilia* ; but they often include members of other families.

Of the *Menelaides* group of Papilios, *hector* and *aristolochiae* (the models for two of the forms of *polytes*) are more abundant at sea-level though they penetrate far into the hills, in diminishing numbers. But the finest species of this group, the beautiful *jophon*, is more retiring in its habits and is to be found, in company with the sylph-like *Hestia jasonia*, in jungle-clad ravines. I shall not readily forget my first sight of this grand "swallow-tail." It was a female, and its movements clearly indicated that it was intent upon egg-laying. I remembered that neither the larva nor the food plant of this species was then known. Here was an opportunity for discovery of which I was eager to avail myself. I followed that butterfly, backwards and forwards, through thickets and over rocks, for nearly half an hour. I thought I had never seen such a vacillating creature. It would hesitate for some time at one shrub, then move off to another to repeat the same disappointing performance. But, eventually, I was rewarded by seeing the insect settle momentarily and bring the tip of its abdomen up against the leaf stalk of a certain plant. To cut matters short, I then netted the butterfly, secured the egg, which I brought through successfully, and now have the parent and offspring in my collection. Knowing that the other members of the group pass their larval stages upon various species of *Aristolochia*—a family of climbing plants—I was surprised to find that *jophon* had selected a woody shrub, until identification of the plant proved it to be a *Bragantia*, a plant which—though of very different habit and appearance—is included in the natural order Aristolochiaceae.

The association of species with particular Orders of plants

has always interested me. An analysis of the food plants of the fifteen species of Papilioninae, in Ceylon, shows that four (*darsius*, *hector*, *jophon* and *aristolochiae*) feed upon Aristolochiaceae; four (*demoleus*, *mooreanus*, *parinda* and *polytes*) upon Rutaceae; another four (*alcibiades*, *nomius*, *jason* and *agamemnon*) upon Anonaceae; two (*lankeswara* and *teredon*) upon Lauraceae; and a single species (*crino*) upon plants of the Order Meliaceae. It will be seen that this grouping agrees almost exactly with the natural affinities of the several species, *teredon* alone having deserted its clan—the Anona feeders. A similar analysis of the food plants of the Pierinae reveals the fact that, of the twenty-eight species occurring in Ceylon, no fewer than thirteen (approximately 50 per cent.) are addicted to a diet of *Capparis* and its allied genera. This group contains species of nine different genera, namely—*Leptosia*, *Appias*, *Belenois*, *Hebomoia*, *Prioneris*, *Huphina*, *Nepheronia*, *Ixias* and *Teracolus*. A second large group of eight, comprising the several species of *Catopsilia* and *Terias*, affects plants of the Order Leguminosae. Of the remainder, *Delias eucharis* is (like its congeners in other countries) restricted to the Loranthaceae, *Teracolus amata* has been recorded as feeding upon *Salvadora*, while the larvae of four species of *Appias* and of one *Teracolus* are still unknown. Here we find that practically the whole of the Pierines are restricted to two out of the 150 Orders of flowering plants occurring in Ceylon. Again, all the Danaine species in Ceylon feed upon plants of the two closely allied Orders Apocynaceae and Asclepiadaceae, all the species of which produce an acrid (and often poisonous) latex. Is it possible that the distasteful properties of these butterflies may be derived from the plants upon which they feed?

Though the butterfly fauna of Ceylon is comparatively rich, it contains very few species that are restricted to the island. As might be expected, by far the greater number occur also in Southern India, or are local races of Indian species. De Nicéville remarks that "there is very little evidence of any connection with the Malayan region," and mentions that only three species—*Danais exprompta*, *Euploea corus* and *Elymnias singhala*—are more nearly related to Malayan than to S. Indian forms. Of the species that are strictly peculiar to Ceylon the

most striking are *Danais taprobana*, of a deep smoky brown colour, boldly splashed with hyaline spots and streaks; *Cethosia nietneri*, with the outer margin of both wings deeply serrated, the serrations accentuated by a submarginal series of conspicuous white arches, and the glorious bird-winged butterfly, *Ornithoptera* (or *Troides*) *darsius*, with its regal mantle of black velvet and old-gold satin.

The periodic, vast, migratory flights of certain butterflies have been frequently described, but never adequately explained. The solution of the mystery requires a large number of skilled observers, distributed over a wide area of country. Unfortunately, interested observers are few and far between, in the East. The phenomenon is, most probably, intimately connected with the distribution of the food plants, which would be affected by the alternating wet and dry seasons on the two sides of the island. Be the explanation what it may, the spectacle of myriads of butterflies, all moving in the same direction, as far as the eye can see, is a truly amazing one. At one time the flights will be composed of sombre-coloured Euploeas, which have the appearance of drifting lazily past, with plenty of time to spare. On another occasion, when the several species of *Appias* are migrating, you have almost the appearance of a snowstorm; but now the butterflies are in a desperate hurry to reach their objective. There is no lagging, no stopping for refreshment by the way. They seem to be impelled forward by some relentless force. The late Colonel Manders, by counting the numbers passing between two fixed points, twenty yards apart, estimated that not less than 14,000 must have crossed a line uniting these points during a period of four hours. This was in open country, at sea-level. In the hill country, where flights have been condensed along intervening valleys, this estimate would be far below the mark. Under such conditions I have seen the butterflies so crowded together as to obscure the view of more distant objects.

I must not occupy too much time over the butterflies, which have received more general attention than have the other Orders of insects. But I should like to say a few words about *Kallima philarchus*—the only one of the "Leaf butterflies"

with which I have any personal acquaintance. All the species of the genus agree in their remarkable resemblance to a dead leaf, when at rest with their wings folded. The apex of the fore-wing is pointed, and the anal angle of the hind-wing is produced into a lobe which simulates the stalk of a leaf. The resemblance is accentuated by the markings of the wing, which suggest the midrib and lateral veins of a leaf. It even copies the frequent blemishes that are found on a dead leaf. In most illustrations of the insect, and in museum exhibition cases, the butterfly is represented as having taken up its position on a leafy branch where it has occupied a convenient gap in the natural series of leaves. I should be sorry to assert that it never perches upon a living branch; but, if such were its regular habit, one would expect that the coloration of the under-surface would have assumed a greenish tint, to harmonise with its surroundings; whereas a brown leaf, attached in its normal position on a living branch, would be somewhat conspicuous. But, in my experience, the butterfly more usually settles, head downwards, on the trunk of a tree, where it sways gently from side to side. In such an attitude it would be mistaken for a detached leaf that—in its fall—has hitched up in a cobweb and is being stirred by the breeze.

It is impossible to give even approximate figures of the number of moths that are to be found in Ceylon. Although local entomologists have been comparatively few in number, extensive collections have been formed during a period extending well over sixty years; yet our knowledge of the Heterocera is still far from complete, and I venture to assert that any enthusiastic collector, working systematically, in some of the wilder parts of the island, would turn up many new species even amongst the so-called Macrolepidoptera. As for the Microlepidoptera, the large number of species already described probably represents but a small percentage of the whole. And there is a wealth of interesting and valuable work to be done in the study of their life histories.

In a general review of the moths of Ceylon it is interesting to note the relative prevalence of some families in comparison with those of our British moths. Sphingidae are well represented, the list containing at least fifty, including no less than

seventeen distinct species of the Macroglossinae. Unlike the European *stellatarum*, which delights in sunshine, these tropical " Humming Bird " moths do not fly during the heat of the day, but appear on the wing in the cool of the evening and continue feeding for some time after nightfall. The two " Bee Hawks " (*Cephonodes hylas* and *C. picus*), on the other hand, prefer the sunlight.

When I first arrived in Ceylon, the cultivation of cinchona (the source of quinine) was at its height, and I soon became acquainted with the larvae of the beautiful " Oleander Hawk " (*Daphnis nerii*), which found a congenial food in the succulent leaves and shoots of the cinchona plants. At one time they multiplied so prodigiously as to become a serious pest. It was found necessary to collect and destroy them—literally by the bushel.

Notodontidae are somewhat weakly represented, the total number of species being less than that in the British list. There is no species of the typical genus *Notodonta*; but there are representatives of the genera *Phalera*, *Cerura*, *Ichthyura* and *Stauropus*. Of the last mentioned genus I had an interesting experience. My duties as Government Entomologist brought me into contact with many remarkable outbreaks of insect pests. On one occasion I received an urgent telegram imploring my assistance on an estate where many acres of tea were said to have been completely defoliated by some strange caterpillar. When I arrived on the spot, I found that the conditions had by no means been exaggerated. More than fifty acres of tea were involved, and large areas had been stripped absolutely bare. The insect that was responsible for this damage was the larva of *Stauropus alternus*, the Eastern representative of our British " Lobster " caterpillar. Some idea of the severity of the attack may be gained by the number of caterpillars actually counted on individual bushes. Referring to a report made at the time, I find that " three average trees, in the middle of the field, yielded severally 306, 327 and 503; while 1,849 fully-grown caterpillars were removed from one specially loaded bush. Putting the average at 350 only, this one field of twenty-four acres (with 3,500 tea bushes per acre) must have harboured, on this

particular day, 29,400,000 caterpillars. Besides the caterpillars actually present on the bushes, vast numbers were wandering about on the ground, searching for more food. Others were to be seen climbing up the mango and other trees growing amongst the tea. There was a distinct and continuous sound of the mastication of leaves, accompanied by a pattering of pellets of excreta as they fell in showers upon the ground." "Coolies employed in collecting the caterpillars complained of being bitten or stung by them. Having previously handled the caterpillars, in small numbers, without inconvenience, I thought this complaint must be imaginary; but, when I began to remove them from one of the infested bushes, I found that they ejected a fluid smelling strongly of formic acid. If any of this fluid penetrated a wound or scratch it produced considerable pain and, a few days later, large blisters formed on my finger-tips." It should be mentioned that, until this sudden outbreak, the caterpillars of *Stauropus alternus* were far from common and considered somewhat of a prize by the collector of Lepidoptera.

Limacodidae, which are represented in this country by two small and inconspicuous species only, number approximately thirty, in Ceylon; ranging from large moths with a wing expanse of over two inches, down to species smaller than our own *asella*. Amongst them are several pests of economic importance, and as the larvae of many species are armed with a formidable array of urticating spines, the task of removing them is distinctly unpleasant. The Indian crow, however—a bird closely allied to our own Carrion Crow—will gorge itself to repletion upon some of these stinging larvae.

One cannot pass over the Ceylon moths without some reference to the Saturniidae, of which the "Emperor" moth is our only British example. In tropical countries this family includes gigantic species such as *Attacus atlas*, of which I have seen individuals with a span of twelve inches. The tip of the falcate fore-wing of this insect, when seen projecting from beneath a leaf, has a curious resemblance to the head of a snake, which may (or may not) be of protective value.

The caterpillars of *Attacus ricini*—a smaller species—are cultivated for the sake of the rather coarse but remarkably tough silk that they produce; while the wild cocoons of *Antheraea paphia* are the source of the "Tussore silk" of commerce. But the most strikingly beautiful species is the so-called "Moon Moth" (*Actias selene*), with wings of a pale sea-green colour, the hind-wings produced into long twisted tails. In the centre of each wing is a circular scale-less area with a dark lunar mark on its inner edge. Another Saturniid, *Cricula trifenestrata,* constructs a conspicuous cocoon composed of a network of stout, golden-yellow strands.

Following closely upon the Saturniidae come the Eupterotidae, a family of rather large moths which is entirely unrepresented in the British Isles. The moths bear a general resemblance to those of the Lasiocampidae, with which family they were, at one time, combined. They are distinguished from the Lasiocamps by the presence of a frenulum. The European "Processionary caterpillar" (*Cnethocampa processionea*) is a member of this family. An analogous habit is noticeable in the larvae of certain Ceylonese species which congregate, during the daytime, in enormous numbers upon the trunks of trees, whence they march, at nightfall, to their feeding-grounds. These compact aggregations of hairy caterpillars, covering—sometimes—an area of a square yard or more, are conspicuous from a considerable distance and have a most remarkable appearance, resembling the body of some furry mammal flattened against the trunk. The caterpillars are so closely massed together that, even at close quarters, they look like a homogeneous pelt. Being so conspicuous, it is not surprising to find that they are well protected by an undergrowth of needle-like, minutely barbed spines. My first acquaintance with one of these gatherings was exceedingly painful. Pushing my way through dense jungle, I accidentally placed my hand upon the mass of caterpillars, with the result that hand and wrist were bristling with these Lilliputian arrows. An attempt to brush them off made matters worse, for they broke off short, leaving the points still embedded in the skin. They have no marked urticating properties, but the mechanical irritation from the hundreds

of spicules is intense. To obtain relief, every individual spine must be picked out with the aid of a pair of fine forceps. The large, loose cocoons are equally formidable; the last act of the caterpillar being to force its detachable spines through the texture of the cocoon, where they remain projecting in every direction. In spite of this protective armament, these caterpillars are a favourite food of a certain species of cuckoo.

There are very few true Zygaenidae in Ceylon, and such as there are are small and dull coloured; but the closely allied subfamily of Chalcosiinae provides some large and brightly coloured forms which, when on the wing in bright sunshine, might easily be mistaken for butterflies, of which some of the Indian species are recognised mimics. The larvae of *Heterusia cingala* are sometimes responsible for serious loss to the tea-planters, many acres of tea being completely defoliated during the periodic outbreaks of this pest. The caterpillars are limaciform, with series of wart-like prominences, each prominence surmounted by a globule of viscid secretion which is probably protective, as the larvae are not attacked by birds.

Psychidae are strongly represented and are common (and unwelcome) objects on the tea plantations, where they are known as "bag-worms" and "faggot-worms."

The Cossidae are few in species, but one of them—*Duomitus leuconotus*—is a giant of its kind, the females having a wing expanse of from seven to eight inches. This species is a most beautiful example of protective coloration. It is interesting to find, in this family, one of the few moths that are common to Britain and Ceylon, namely, *Phragmatoecia castanea*.

Hepialidae are represented by a single species only—*Phassus purpurescens*, a large and handsome insect with a span of over five inches.

It would occupy too much time to go through the moths, family by family; but, before leaving the subject, I should like to describe some of my experiences of nights spent in the jungle with a powerful light to attract moths and other night-flying insects. Of course there were many blank nights when there was no response to my lure; but even so there was a charm in feeling that one was alone with nature. The

wonderful stillness and apparent silence. I use the term "apparent" advisedly. There is no real silence in the tropics. The air is actually permeated by a myriad tiny voices, blended together into one harmonious note which could be appreciated only were it suddenly to cease. This silence occasionally punctuated by the sharp "toc toc" of one of the larger tree-frogs, or the cry of a night bird. Then the fairy-like (almost theatrical) effect of the light, brilliantly illuminating the foliage of the foreground in strong contrast with caverns of mysterious blackness beyond. It is upon this outer darkness that one's attention is fixed with expectancy, for, at any moment, some shadowy form may appear and, after a period of hesitancy, advance into the full blaze of the light. Sometimes an unexpected visitor puts in an appearance. A dazzled cuckoo invaded my tent on one occasion. On another, I was intently watching the shadows when a slight movement attracted my eye. Presently the head and forepart of a huge Indian python was revealed. After a mutual inspection of some minutes, the snake retired into the obscurity from which it had emerged.

But there are other times when the opposite conditions prevail. Instead of rest and silence, all is activity and noise. One such occasion is impressed upon my memory. I and a friend had erected our light-traps upon the edge of a lake in the low country. From the moment that darkness fell insects, of all orders, flocked to our lights. At the same time there arose such a deafening chorus of frogs that, to obtain relief, I had to plug my ears with cotton wool. Mosquitos and Chironomids blackened the walls of the tents and were scattered by the wild dashes of large moths, water bugs, Mantises and other weird creatures. Presently a sharp shower of rain fell, succeeded immediately by an invasion of winged termites which took temporary possession of the tents. It was on this occasion that I first observed the activities of the fly *Ochromyia jejuna*. Following closely upon the termites came a small army of these flies, which proceeded to pounce upon and carry off the helpless insects. An invasion of termites would, at first sight, give the impression that further work would be useless. They assemble in

their thousands. The light, if not screened, would quickly be extinguished. The space inside the tent is a welter of fluttering wings. But, within a quarter of an hour, everything is clear again; the termites have shaken off their wings and crept out of sight.

In working, as I have often done, throughout the whole night, maximum and minimum periods of attraction are noticeable. There is an early evening flight of moths, at its height for an hour after dark and gradually diminishing till midnight, when there is a distinct lull of several hours during which the watcher can recuperate himself with a short rest. Then there is a reverse process: stragglers commence to appear, in gradually increasing numbers, until the second (though smaller) maximum occurs during the last hour before daybreak.

It may be remembered that, during the Boer War, a large Prisoners' Camp was established in the hills of Ceylon. This camp was surrounded by a ring of powerful arc lights. Whether by reason of the novelty of the lights, where no such powerful lamps had been seen before, or from the hitherto unsuspected richness of the insect fauna of the locality, moths in incredible numbers were attracted, night after night. The late Colonel Manders, himself a keen entomologist, who was stationed at the camp, invited me to spend a few nights on the spot, an opportunity of which I gladly availed myself. I subsequently published an account of this unique experience in *The Entomologist's Monthly Magazine* of April 1901. As present-day memories are short, I am tempted to conclude my Address by quoting freely from this article, which appeared nearly a quarter of a century ago.

" The Boer camp is situated in a small hollow in the midst of the undulating patna land at Diyatalawa, at an elevation of about 4,000 feet. The electric lamps are visible from the surrounding hills within a radius of three miles and, where there are no hills to interrupt the view, the glare of the lights must be noticeable from a much greater distance. The country for miles round is open, the vegetation consisting of wiry grass and the usual small patna plants. With the exception of a

few patches of scrub in an occasional hollow, there is no wooded land that could provide breeding ground for the myriads of moths that are nightly attracted. The nearest forest is fully two miles distant. Yet it is remarkable that the greater number of moths seen and captured are such as feed, in the larval stage, on plants and trees not present on the patnas.

"The lamps are of a nominal 2,000 candle-power. The standards, made of sawn timber about twenty-five feet high, form an admirable resting-place for the dazzled moths.

"The lamps are lighted at dusk, which, at this season, is soon after 6 p.m., but it is some little time before the insect crowd assembles. The fun was in full swing when we started on our rounds at nine o'clock. From a little distance every lamp was seen to be surrounded by a whirling swarm of brilliantly illuminated objects. As we approached, the grass was spangled with dazzled moths and, for several yards round the foot of each post, the ground was simply carpeted with them. It became impossible to walk without treading upon them. The post itself was encrusted with moths of all sizes, from the large Saturniids and Sphingids to the smallest Noctuids and Pyrales. Very few Tineids were noticed. Upon one single post I counted thirty-nine specimens of the handsome hawk moth *Pseudosphinx discistriga*, while *Daphnis hypothous* and *Theretra nessus* almost rivalled the *Pseudosphinx* in numbers. But by far the most prominent species were the Noctuids—*Oxyodes scrobiculata* and *Maceda mansueta*. These two species were present in tens of thousands. The moths rested most thickly high up on the post close to the lamp. A pair of Zeiss field-glasses proved most useful for scrutinizing this part of the post. It was a wonderful sight to see all these handsome moths in such close proximity to each other, the smaller species filling up the interstices between the wings of the larger, or even superimposed upon them.

"I was surprised to find that, on the occasion of my visit, neither bats nor goatsuckers were availing themselves of the feast that was ready for the taking. Only an occasional toad was deliberately loading itself up with the smaller moths

that fluttered to the ground. Several
filled themselves to repletion and, when touched, turned over on their backs and gazed at the brilliant light in a condition of semi-hypnotism.

"Most of the lamps are set in the track of the sentries, and the heavy foot of the British soldier had extinguished many a glorious specimen that would have gladdened the heart of an English entomologist. The path was decorated with a mosaic of variegated wings and bodies crushed into the mud.

"Some thirty lamps or more completed the circuit. Each one of these was visited in turn. By the time the round had been accomplished it was past midnight. I was warned, however, that an early morning visit was advisable, before the crows, sparrows and swallows had commenced their work of destruction. So we started again at daybreak and found the moths almost as we had left them, except that they were now all at rest and selection could be made with greater ease and deliberation. But now we were not the only collectors. An army of birds (sparrows and swallows, assisted by an occasional crow) was busily at work. The sparrows fluttered against the posts, knocking off a cluster of moths and pounced upon such as fell to the ground; while the swallows exterminated those that attempted to escape by flight. We amused ourselves by starting an occasional flight of moths and observing how the swallows unerringly avoided the several species that were protected by an offensive smell, such as *Hypsa complana*, *H. producta* and *Pelochyta astrea*. This last insect, when handled, emits a quantity of evil-smelling froth from each side, immediately behind the head.

"The same performance was repeated on the second night, when, if possible, an even larger assemblage of moths was present. It is difficult to understand whence such myriads of insects could be drawn, each night, never to return to lay their eggs. A long continuance of these conditions must inevitably lead to the extinction of many species from that district. The attraction has now been in force for four months. The crowd is denser on some nights than on others. Moths do not assemble, to any extent, when a cold wind is

blowing, and strong moonlight is deterrent. Warm damp nights, after rain, produce the heaviest crops.

"In addition to the moths, other Orders of insects, chiefly Hemiptera, were represented. The giant water-bug, *Belostoma indicum*, was dashing about in every direction, while the brightly coloured *Catacanthus incarnatus* and the 'stink-bug' par excellence, *Nezara viridula*, were to be seen on every post.

"Some of the Boer prisoners have occupied their leisure in catching the moths that settle within their bounds and have, in this way, amassed quite considerable collections. I noticed several rarities in their boxes and, also, a magnificent Noctuid that was quite unknown to me. I tried to induce the wily Boer to sell, but money was of no object to him and he refused to part with his treasure for any consideration. These men were working under great disadvantages. The lamps are outside the barrier and only a small percentage of the moths settle within their lines. Then they have to be within doors soon after sundown. They have no proper apparatus for collecting and preserving their specimens, but have manufactured for themselves rough setting-boards and store-boxes. In the face of all these difficulties several collections of real merit have been formed."

And now, Ladies and Gentlemen, having occupied (and, I fear, wearied) your attention for so long a time, I hasten to release you. I have placed on exhibition specimens of some of the more notable insects mentioned in my Address.

GENERAL INDEX.

The Arabic figures refer to the pages of the 'Transactions'; the Roman numerals to the pages of the 'Proceedings.'

The President's Address is not separately indexed.

GENERAL SUBJECTS.

SPECIAL INDEX.

The Arabic figures refer to the pages of the 'Transactions'; the Roman numerals to the pages of the 'Proceedings.'

ERRATA.

TRANSACTIONS, 1923.

Page 208, line 18, and page 214, line 24, for *Cydamon* read *Cydimon.*
,, 374, 2 lines from bottom, *for* Lionel *read* Louis.
,, 414, 4 lines from bottom, for *H. densatfrons* read *H. densatifrons.*
,, 418, line 15, for *H. plebejus* read *H. plebeius.*
,, 436, line 10, for *rudestriatis* read *rudestriatus.*
,, 443, line 1, *for* 1889 *read* 1899.
,, 495, line 19, for *T. viridissimo* read *T. viridissima.*
,, 501, line 1, for *Rhacoclees* read *Rhacocleis.*
,, 515, 5 lines from bottom, for *chritinici* read *christinici.*
,, 523, lines 30, 31, 35, and page 524, line 7, for *G. shelkovnikovae* read *G. schelkovnikovae.*
,, 567, line 33, *for* Frederick *read* Frederic.
,, 682, line 11, *for* Fijiau *read* Fijian.
,, 727, line 7, and page 743, line 23, for *coccineus* read *coccinea.*

PROCEEDINGS.

Page xliv, 4 lines from bottom, *for* Thysaneura *read* Thysanura.
,, lxvii, line 16, for *C. triridates* read *C. tiridates.*
,, lxxii, line 3, for *Aphenogastar* read *Aphenogaster.*

PRINTED IN GREAT BRITAIN BY
RICHARD CLAY & SONS, LIMITED,
BUNGAY, SUFFOLK.